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(54)[Title of the Invention] COMPLETELY-SEALED-TYPE GAS-LIQUID CLEANING DEVICE AND CLEANING METHOD

(57) [Summary]

[Object] An object of the present invention is to provide a completely-sealed-type gas-liquid cleaning device which is capable of cleaning with an excellent cleaning efficiency, and a cleaning method thereof.

[Solving Means] A cleaning device of the present invention is a completely-sealed-type cleaning device characterized by having a cleaning fluid inlet for introducing a cleaning fluid into the inside thereof; and a cleaning fluid outlet for discharging the inside cleaning fluid to the outside, and by having a cleaning tank which can be sealed after a cleaning object is housed inside; a tank which is connected to the cleaning fluid outlet and which is for storing the cleaning fluid after cleaning; and pressure-reducing means for causing the inside of the tank to be in a pressure-reduced state.

[Scope of Claims]

[Claim 1] A completely-sealed-type gas-liquid cleaning device having a cleaning fluid inlet for introducing a cleaning fluid into an inside thereof, and a cleaning fluid outlet for discharging the inside cleaning fluid to an outside, characterized by comprising:

a cleaning tank which can be sealed after a cleaning object is housed inside;

a tank which is connected to the cleaning fluid outlet, and which is for storing the cleaning fluid after cleaning; and

pressure-reducing means for making the inside of the tank to be in a pressure-reduced state.

[Claim 2] The completely-sealed-type gas-liquid cleaning device according to claim 1, characterized in that the cleaning tank is made of a material having translucency.

[Claim 3] The completely-sealed-type gas-liquid cleaning device according to any one of claims 1 and 2, characterized in that light irradiation means for irradiating the inside of the sealed cleaning tank with light is provided outside the cleaning tank.

[Claim 4] The completely-sealed-type gas-liquid cleaning device according to any one of claims 1 to 3, characterized in that pressure-increase means, which is for increasing the pressure in a cleaning fluid to be introduced into the inside of the cleaning tank, is

provided.

[Claim 5] The completely-sealed-type gas-liquid cleaning device according to any one of claims 1 to 4, characterized in that heating means for heating the inside of the cleaning tank is provided.

[Claim 6] The completely-sealed-type gas-liquid cleaning device according to any one of claims 11 to 5, characterized in that the heating means is an infrared lamp provided outside the cleaning tank.

[Claim 7] The completely-sealed-type gas-liquid cleaning device according to any one of claims 1 to 6, characterized in that the pressure-reducing means is an aspirator.

[Claim 8] The completely-sealed -type gas-liquid cleaning device according to any one of claims 1 to 7, characterized in that the cleaning fluid is a liquid.

[Claim 9] The completely-sealed-type gas-liquid cleaning device according to any one of claims 1 to 7, characterized in that the cleaning fluid is a gas.

[Claim 10] The completely-sealed-type gas-liquid cleaning device according to any one of claims 1 to 9, characterized in that a plurality of cleaning fluid sources are connected to the cleaning fluid inlet through valves.

[Claim 11] The completely-sealed-type gas-liquid cleaning device according to any one of claims 1 to 10, characterized in that purification means, which is for purifying the cleaning fluid stored in the tank after cleaning, is provided.

[Claim 12] The completely-sealed-type gas-liquid cleaning device according to claim 11, characterized in that a circulation line for causing a purified cleaning fluid, which is purified by the purification means, to flow back into the cleaning fluid source.

[Claim 13] The completely-sealed-type gas-liquid cleaning device according to any one of claims 1 to 12, characterized in that a trap is provided downstream of the pressure-reducing means.

[Claim 14] The completely-sealed-type gas-liquid cleaning device according to any one of claims 1 to 13, characterized in that a switching valve, which is for making the cleaning fluid inlet serve as a port for discharging the inside cleaning fluid inside to the outside, and for making the cleaning fluid outlet serve as a cleaning fluid inlet for introducing a cleaning fluid to the inside, is provided. The complete-sealed-type

gas-liquid cleaning device comprises: a cleaning tank which can be sealed after a cleaning object is housed inside; and a tank which is connected to the cleaning fluid outlet and which is for storing the cleaning fluid after cleaning.

[Claim 15] A completely-sealed-type gas-liquid cleaning method characterized in that a cleaning tank is sealed after the cleaning object is placed inside the cleaning tank; insides of the cleaning tank, a line, and a tank become in a pressure-reduced state by discharging air in the cleaning tank and the tank communicating with the cleaning tank through the line; and then, by making the cleaning tank in the pressure-reduced state and a chemical fluid supply source become in a communicating state, the chemical fluid is introduced to the inside of the cleaning tank.

[Claim 16] The completely-sealed-type gas-liquid cleaning method according to claim 15, characterized in that when the cleaning tank and the chemical fluid supply source are in the communicating state, air discharging in the pressure-reduction tank is suspended.

[Claim 17] The completely-sealed-type gas-liquid cleaning method according to claim 15, characterized in that when the cleaning tank and the chemical fluid supply source are in the communicating state, air discharging in the pressure-reduction tank is being performed.

[Claim 18] The completely-sealed-type gas-liquid cleaning method according to claim 15, characterized in that the pressure-reduced state is at not higher than 100 Torr.

[Claim 19] The completely-sealed-type gas-liquid cleaning method according to claim 18, characterized in that the pressure-reduced state is at 10 Torr to 100Torr.

[Claim 20] The completely-sealed-type gas-liquid cleaning method according to any one of claims 15 to 19, characterized in that the cleaning fluid is pressurized and the cleaning fluid is introduced into the cleaning tank.

[Claim 21] The completely-sealed-type gas-liquid cleaning method according to any one of claims 15 to 20, characterized in that a plurality of cleaning steps are successively carried out in the single cleaning tank.

[Claim 22] The completely-sealed-type gas-liquid cleaning method according to any one of claims 15 to 21, characterized in that the cleaning fluid is a liquid.

[Claim 23] The completely-sealed-type gas-liquid cleaning method according to any one

of claims 15 to 21, characterized in that the cleaning fluid is a gas.

[Detailed Description of the Invention]

[0001]

[Field of the Industrial Applicability] The present invention relates to a completely-sealed-type gas-liquid cleaning device and a cleaning method thereof.

[0002]

[Prior Art] A conventional technology will be described, taking a very large scale integrated circuit as an example. Manufacturing of the very large scale integrated circuit is carried out by repeating steps of forming a thin film such as a metal film or an insulating film on an entire surface of a silicon wafer, and of etching and removing the thin film in a manner that only necessary patterns are left.

[0003] Recently, in some cases, processing, that is, the "CMP (chemical mechanical planarization) processing" for flattening an uneven surface of a wafer is adopted, and to the surface of the wafer processed through the CMP processing, remaining abrasive powders are attached. Removal of the abrasive powders is not easy.

[0004] Accordingly, before and after each step, a cleaning step for removing various contaminants on the wafer is required.

[0005] The following conditions are required for a wafer before each manufacturing process.

(1) There is no contamination by particles.

(2) There is no metal contamination.

(3) There is no organic contamination.

(4) There is no moisture absorption.

(5) There is no natural oxide film.

(6) There is no unevenness on the surface at an atomic scale.

(7) A surface of silicon is completely hydrogen-terminated.

(8) There is no electrification.

[0006] Currently, generally-used cleaning methods are composed based on a wet cleaning method (RCA cleaning) by use of a chemical fluid containing a hydrogen peroxide solution as an essential component. An example is shown in Table 1.

[0007]

[TABLE 1]

Cleaning fluid	Mixing Ratio	Used Temperature	Objects to be Cleaned
H_2SO_4 / H_2O_2 (SPM)	4:1	120°C	Organic Material, Metal
H_2O rinse		Room Temperature	Chemical
HF / H_2O (DHF)	1:100	Room Temperature	Natural Oxide Film
H_2O rinse		Room Temperature	Chemical
NH_4 OH/H_2 O_2/H_2O (APM)	1:1:5	70-90ΩC	Particles, Organic Material
Hot H_2O rinse		80ΩC	Chemical
H_2O rinse		Room Temperature	Chemical
HCL/H_2 O_2/H_2O (HPM)	1:1:6	70-90ΩC	Metal
H_2O rinse		Room Temperature	Chemical
HF / H_2O (DHF)	1:100	Room Temperature	Natural Oxide Film
H_2O rinse		Room Temperature	Chemical

[0008] In a case of performing such cleaning, as shown in Fig. 5, a wafer 2, which is expected to be processed by one-piece or in a batch, is immersed and cleaned in a SPM cleaning tank 1a having an upper part opened. After the SPM cleaning, the wafer 2 is taken out from the SPM cleaning tank 1a into the atmosphere by use of a transfer system (not illustrated), and is rinsed with purified water for the purpose of removing SPM. Subsequently, by means of the transfer system, the wafer 2 is immersed and cleaned sequentially in a DHD tank 1b, an APM tank 1c, a MHP tank 1d, and a DHF tank 1e, each of which also has an upper part opened. Rinsing with purified water is performed between each cleaning.

[0009] However, there have been the following problems with respect to the above-described conventional technology.

[0010] (1) In general, when cleaning is performed, a cleaning fluid and contaminants react with each other and result in generation of a reaction product gas. It goes without saying that when this reaction product gas is discharged into a clean room, the clean room is contaminated.

[0011] This reaction gas remains in the cleaning tank and dissolve into the cleaning fluid. Accordingly, in a case where a cleaning object is so large that a large amount of reaction product gas is generated, the amount thereof exceeds a limit of saturation solubility of a cleaning fluid. When the saturation solubility is exceeded, it becomes difficult to progress a reaction between the cleaning fluid and contaminants, and then, this leads to deterioration in cleaning efficiency.

[0012] Further, when the cleaning fluid is degraded, the cleaning fluid is drained from the cleaning tank, and the drained fluid is disposed of. With respect to an environmental aspect, it is necessary to perform processing on the drained fluid ahead of the disposal. However, in the conventional technology, the processing is difficult because the drained fluid is in a state where the cleaning fluid and the reaction product gas coexist.

[0013] In addition, in the conventional technology, there is also a problem that since the draining is performed directly in the tank which is exposed to the atmosphere, unfavorable substances are mixed in the cleaning tank.

[0014] (2) Since the cleaning object (for example, a wafer) 2 is transferred in the atmosphere by the transfer system at each time of transfer between tanks, particles and contaminants in the atmosphere are attached to the cleaning object 2.

[0015] Additionally, dust is also generated in the transfer system, especially from sliding parts, and the dust is also attached to the wafer 2 which is the cleaning object.

[0016] (3) Due to the cleaning, the particles, dust and the like are detached from the surface of the wafer. However, the detached particles and dust flow in the vicinity of the cleaning object or float on a surface of a chemical fluid because the chemical fluid flows slowly. There are some cases that such particles, dust and the like are attached again to a cleaning object in a chemical fluid, or when the cleaning object is raised up from the chemical fluid tank.

[0017] (4) Further, the conventional cleaning device discharges ion mist into the clean room because the top part thereof is opened.

[0018] For this reason, the cleaning device needs to be arranged separately from other film forming devices. Consequently, it has been obliged to accept a limitation on a

layout design of devices in the clean room.

[0019] For example, it is not possible to arrange the cleaning device near an aligner using a resist, and accordingly, it is forced that the aligner and the cleaning device are arranged separately from each other.

[0020] Furthermore, it is necessary to discharge a large amount of clean air through the cleaning device in order to prevent the mist from entering the clean room. For this, in consideration of a pressure drop in a discharging duct, it is necessary to use a large-diameter duct and make the duct as short as possible. As a consequence, it is not possible to arbitrarily determine a installation location of the cleaning device, and constraints are imposed thereon in relation to a discharged-gas processing device or the like. Still further, a large discharged-gas processing device (scrubber) is required to remove chemical vapor in a large amount of discharged air, while an air conditioning device for an intake of a large amount of fresh air is necessary in order to make up for the discharged clean air.

[0021] As described, the conventional cleaning device increase an equipment cost and a maintenance cost of a clean room, and additionally, a installation location thereof in the clean room is limited. As a result, it is not possible to arrange each semiconductor manufacturing device in an optimum location from the processing point of view, and a transfer distance to a processing device of a next step after cleaning is increased. Accordingly, there have become problems of contamination and the like of a semiconductor substrate during transfer by clean air in manufacturing of high performance integrated devices.

[0022] For instance, a space of a clean room plant, where approximately three million 16 M-bit or 64 M-bit DRAMs are manufactured per month, is significantly upsized to be approximately $80\times200m^2$, and approximately 20% of approximately five-hundred process steps in total is cleaning steps. Consequently, a transfer distance of a semiconductor substrate through the whole steps becomes close to 10km. Additionally, in a case of a closed system in which a transfer is carried out through a nitrogen tunnel or a nitrogen box, inhibition of the surface contamination is possible. However, a transfer path becomes longer and complicated, and a cost thereof becomes so enormous that the

realization thereof has not been possible in practice.

[0023] Furthermore, as existing discharged-air processing devices, what is termed as "scrubber" is widely used. However, discharged air of some types of chemicals is not sufficiently processed and the air containing contaminants is discharged into the atmosphere although it is a very small amount. Accordingly, a scrubber is generally arranged on a leeward side of an intake port of fresh air of the clean room, in order that gas discharged from the scrubber is not taken into the clean room. However, in some cases, the scrubber is arranged on a windward side of the intake of fresh air, depending on wind directions. In this case, the chemical vapor is taken into the inside of the clean room, and as a result, the inside of the clean room is contaminated. For this reason, a high exhaust port is prepared and the flow rate of the discharged air is sufficiently increased, whereby the discharged gas is emitted high up in the air. Additionally, as described above, in consideration of the path of the discharging duct to enhance an efficiency of air discharge, there is also a limitation on the locational relationship between the installation locations of the cleaning device and of the scrubber in the clean room.

[0024] Furthermore, recently, in order to realize higher integration, it has begun considering a chemical-sensitizing resist. However, this resist sensitively reacts with a very small amount of ammonium as 10ppb, and this causes a change in a resist shape. Accordingly, in a case of using ammonium in the RCA cleaning or the like, meticulous attention needs to be paid in order that an ammonium mist and the resist have no contact with each other. Consequently, it is required that the cleaning device and a photolithography device are arranged in a way completely separated from each other.

[0025] As described above, in the conventional cleaning technology, since the mist is discharged inside the clean room, the installation location of the cleaning device in the clean room is limited. Moreover, a further limitation is imposed on the installation location in relation to an influence of chemicals on other steps, the chemical being used in the cleaning device, and the discharged-air processing device. Consequently, it is not possible to arrange each manufacturing processing device in accordance with an optimum locational relation for the manufacturing process, in other words, in accordance

with the manufacturing process order. As a result, there is a problem that a transfer distance of a semiconductor substrate becomes extraordinary long, and this prevents a high productivity in producing semiconductor devices and a high yield thereof.

[0026] (5) In addition to this, in the conventional cleaning technology, because a tank has an upper part opened, a cleaning fluid is limited to a liquid and gaseous material having cleaning effects cannot be used. (6) Furthermore, it is difficult to completely remove abrasive powders attached to a surface after applying CMP.

[0027]

[Problems to be Solved by the Invention] An object of the present invention is to provide a completely-sealed-type gas-liquid cleaning device which is capable of cleaning with an excellent cleaning efficiency, and a cleaning method thereof.

[0028] An object of the present invention is to provide a completely-sealed-type gas-liquid cleaning device which makes processing of a degraded cleaning fluid easy.

[0029] An object of the present invention is to provide a completely-sealed-type gas-liquid cleaning device in which contamination in a cleaning tank by unfavorable substances in is not caused during disposing of a cleaning fluid.

[0030] An object of the present invention is to provide a completely-sealed-type gas-liquid cleaning device with which it is possible to avoid contamination by particles from the atmosphere, and contamination by dust from mechanical sections.

[0031] An object of the present invention is to provide a completely-sealed-type gas-liquid cleaning device with which it is possible to avoid reattachment of particles, which have been detached from a cleaning object, thereto.

[0032] An object of the present invention is to provide a completely-sealed-type gas-liquid cleaning device which can expand alternatives in cleaning due to introduction of gaseous fluids.

[0033] An object of the present invention is to provide a completely-sealed-type gas-liquid cleaning device in which a flow rate can be controlled.

[0034] An object of the present invention is to provide a completely-sealed-type gas-liquid cleaning device with which it is possible to prevent mist from flowing into a clean room.

[0035] An object of the present invention is to establish a cleaning technique capable of suppressing a discharge of mist into a clean room, and accordingly is to provide a cleaning device with which it is made possible to realize the shortest transfer distance (wafer flow path minimum) of a semiconductor substrate, which is suitable for production of high-integrated and high-performance semiconductor devices, through entire processing, by arranging semiconductor manufacturing devices approximately in a processing order.

[0036] Further, an object of the present invention is to provide a cleaning device which considerably increases productivity in manufacturing of semiconductors, significantly reduces a running cost in a plant, and enhances freedom in design to a large extent.

[0037]

[Means for Solving the Problem] A cleaning device of the present invention is a completely-sealed-type cleaning device characterized by having a cleaning fluid inlet for introducing a cleaning fluid into the inside thereof; and a cleaning fluid outlet for discharging the inside cleaning fluid to the outside, and by having a cleaning tank which can be sealed after a cleaning object is housed inside; a tank which is connected to the cleaning fluid outlet and which is for storing the cleaning fluid after cleaning; and pressure-reducing means for causing the inside of the tank to be in a pressure-reduced state.

[0038] A cleaning method of the present invention is a completely-sealed-type gas-liquid cleaning method, characterized in that, the cleaning tank is sealed after the cleaning object is placed inside the cleaning tank, insides of the cleaning tank, a line, and the pressure-reduction tank becomes in a pressure-reduced state by vacuuming inside the cleaning tank and the pressure-reduction tank communicating with the cleaning tank through the line, and then the chemical fluid is introduced to the inside of the cleaning tank by making the cleaning tank in the pressure-reduced state and chemical fluid supply source in a communicating state.

[0039] According to the present invention, the inside of the cleaning device is sealed after a cleaning object is housed therein, and is kept in the pressure-reduced state by the pressure-reducing means, whereby there is no contamination by particles from the

atmosphere.

[0040] In addition, even in a case of cleaning with a plurality of cleaning fluids such as the RCA cleaning, a transfer system is not required naturally since it is not necessary to transfer the cleaning object due to sequential introduction of the plurality of cleaning fluids into the single cleaning tank. Consequently, it is possible to avoid contamination by dust from mechanical sections of a transfer system.

[0041] The cleaning fluid is introduced from the cleaning fluid inlet into the inside of the cleaning tank, and is discharged from the cleaning fluid outlet, whereby the cleaning fluid flows constantly. Accordingly, particles detached from the cleaning object by cleaning are instantly discharged from the cleaning fluid outlet into the outside. Consequently, it is possible to avoid reattachment of the particles, which have been detached from the cleaning object, thereto.

[0042] Further, since the cleaning device of the present invention is sealed, not only a liquid but also a gas can be used for cleaning, whereby alternative in cleaning can be expanded enhanced.

[0043] Furthermore, since the cleaning device of the present invention is sealed, there is no mist flowing into a clean room. As a consequence, freedom of arranging the cleaning device is enhanced and it is possible to realize the shortest transfer distance of a semiconductor substrate through entire processing, the semiconductor substrate being suitable for production of high- integrated and high-performance semiconductor devices. In addition to this, a discharge of clean air in the clean room owing to generation of mist becomes unnecessary.

[0044] Still further, in the cleaning device of the present invention, the cleaning fluid keeps flowing constantly, and accordingly, a cleaning object is always cleaned with a fresh cleaning fluid, whereby high efficiency in cleaning can be realized.

[0045] (1) Incidentally, in the present invention, it is preferable that a cleaning tank be configured with a translucent material and light irradiation means, which is for irradiating the inside of the sealed cleaning tank with light, be provided to the outside of the cleaning tank. In terms of the light, infrared rays, ultraviolet rays, visible light or the like may be appropriately selected according to usage.

[0046] For example, an oxygen gas is introduced into the inside of the cleaning tank, and then, the oxygen gas is irradiated by ultraviolet rays, whereby ozone is generated. Accordingly, it is made possible to remove an organic matter from the cleaning object.

[0047] In addition, by means of irradiation of infrared rays, it is made possible to heat the cleaning fluid without causing contamination. In the present invention, by adopting the light irradiation as a heating function, heating without contamination is possible.

[0048] (2) In the present invention, pressure-increase means, which is for increase pressure of a cleaning fluid to be introduced to the inside of a cleaning tank, is preferably provided.

[0049] The cleaning fluid, especially a cleaning liquid, which is to be introduced to the cleaning tank, is pressurized with the pressure-increase means so as to have an appropriate pressure, whereby an introducing flow rate of the cleaning fluid can be controlled. Since the flow rate of the cleaning fluid also influences on cleaning efficiency, optimum cleaning efficiency can be obtained by controlling the pressure thereof.

[0050] (3) In the present invention, heating means for heating the inside of a cleaning tank is preferably provided.

[0051] In the cleaning step shown in Table 1, for example, the cleaning fluid is heated in some case. Accordingly, if the heating means such as an external heater or an internal heater is provided, heating of the cleaning fluid is possible.

[0052] (4) In the present invention, effects become more apparent by connecting a plurality of cleaning fluid sources to a cleaning fluid inlet through valves. Cleaning is performed by use of a plurality of chemical fluids as shown in Table 1 through a plurality of steps. In the conventional steps, when cleaning is performed, a cleaning object is necessarily exposed to the atmosphere between steps and the cleaning object has to be transferred between the steps.

[0053] In contrast, in the present invention, it is possible to perform cleaning through the plurality of steps in a single tank without the transfer, whereby efficiency becomes more apparent.

[0054] (5) In the present invention, purification means, which is for purifying the

cleaning fluid stored in the tank after cleaning, is preferably provided.

[0055] In the present invention, the pressure-reducing means is provided, and an aspirator is preferably used as means for obtaining a clean pressure-reduced state.

[0056] Subsequently, a cleaning method of the present invention will be described with reference to Fig. 4. In the cleaning method of the present invention, first, after a cleaning object 2 is placed inside a cleaning tank 13, the inside of the cleaning tank 13 is sealed and is blocked from the atmosphere.

[0057] Secondly, by discharging air from the insides of the cleaning tank 13 and the pressure-reduction tank 14 communicating with the cleaning tank 13 through a line (discharging line) 29, the insides of the cleaning tank 13, of the line 29 and of the pressure-reduction tank 14 becomes in a pressure-reduced state. Note that, at that time, valves V10, V60 and V6 are closed and the valves V 15, V61, V62 and V63 are respectively opened. In addition, the discharging may be performed by use of discharging means 15, for example, a vacuum pump, an aspirator, or the like.

[0058] Subsequently, the cleaning tank 13 in the pressure-reduced state and a chemical fluid supply source are made to be in a communicating state. This may be performed by opening the valve V10. When the cleaning tank 13 and the chemical fluid supply source become in the communicating state, the insides of the cleaning tank 13, of the line 29 and of the pressure-reduction tank 14 are in the pressure-reduced state. Accordingly, the chemical fluid flows into the inside of the cleaning tank 13, and further flows into the inside of the pressure-reduction tank 14 through a line 29. Because of this, the chemical fluid in a flowing state is obtained, and the cleaning object 2 is cleaned by use of the chemical fluid in such a flowing state. Additionally, a reaction product gas, which is generated during cleaning, is generated, but it is immediately discharged into the inside of the pressure-reduction tank 14 through the line 29. Accordingly, there is no deterioration of cleaning efficiency due to dissolution of the reaction product gas into the chemical fluid, and it is possible to perform cleaning with high efficiency.

[0059] In addition to this, since the chemical fluid after cleaning is discharged to the pressure-reducing pump, there arises no problem of mixing particles into the inside of the cleaning tank due to changes of chemical fluids.

[0060] Note that, in making the cleaning tank 13 and the chemical fluid supply source be in the communicating state (that is, during cleaning), it is acceptable to select any one of cases, where the air discharge inside the pressure-reduction tank 14 (and the cleaning tank 13) is not performed with the valve V62 closed, and where the air discharge is preformed. In the former case, the chemical fluid may be drained, after the valve V62 is opened and the gas collected on the upper part of the pressure-reduction tank 14 is discharged. On the other hand, in the latter case, since if a large amount of gas is discharged, the chemical fluid is drawn toward the vacuum pump, vacuuming may be preformed at a degree of vacuum, at which the above mentioned phenomenon does not occur.

[0061] The cleaning object 2 is left as it is after being cleaned with the chemical fluid, and then, rinsing thereof and the like are consecutively performed in the similar procedure to that of cleaning with a chemical fluid.

[0062] After completion of entire cleaning processing such as the cleaning with the chemical fluid and rinsing, the valve V60 is opened and a cover gas (such as a nitrogen gas) is introduced. Thereafter, when the inside of the cleaning tank 13 becomes at the atmospheric pressure, the cleaning tank is opened. This is because the inside of the cleaning tank 13 is in the pressure-reduced state on completion of the cleaning processing.

[0063] Note that, in a case of performing the successive cleaning with a gas instead of the chemical fluid, it suffices that the valves V62 and V63 are opened and an appropriate trap 44 is used.

[0064] Note that, the pressure-reduced state is preferably at not higher than 100 Torr, and more preferably at 10 Torr to 100 Torr.

[0065]

[Embodiment of the Invention] (First Embodiment) An embodiment of a cleaning device of the present invention will be described based on Figs. 1 and 2. Note that although the embodiment will be described by taking the RCA cleaning as an example, the present invention is not fixed to the RCA cleaning.

[0066] In the embodiment, the cleaning device includes a cleaning fluid inlet 11 for

introducing cleaning fluid 1 into the inside, and a cleaning fluid outlet 10 for discharging an inside cleaning fluid 1 to outside, and includes a cleaning tank 13 which can be sealed after a cleaning object 2 is housed inside, a tank (a pressure-reduction tank) 14 which is connected to the cleaning fluid outlet 10, and which is for storing the cleaning fluid after cleaning, and pressure-reducing means (a vacuum pump) for causing the inside of the tank 14 to be in a pressure-reduced state.

[0067] Note that reference numeral V15 denotes a valve provided downstream of the cleaning fluid outlet 10; and V_{10} denotes a valve provided upstream of the cleaning fluid inlet 11. An example of a detailed configuration of the cleaning tank 13 is shown in Fig. 2.

[0068] The cleaning tank 13 is configured of an upper container 6 and a lower container 7. The cleaning fluid outlet 10 is formed in an upper part of the upper container 6, and the cleaning fluid inlet 11 is formed in a lower container 7. Functions thereof can be preferably changed by switching between valves V_{51} and V_{52}. To be more precise, a point a downstream of the valve V_{15} and a point d upstream of the valve V_{10} are connected with a line 35 having the valve V_{52}, and a point c upstream of the valve V_{15} and a point b downstream of the valve V10 are connected with a line 36 having the valve V_{51}. This makes it possible to introduce the cleaning fluid through the cleaning fluid outlet 11 to the inside of the cleaning tank 13. Additionally, it is made possible to discharge the cleaning fluid from inside the cleaning tank 13 through the cleaning fluid inlet 10.

[0069] In addition, the upper container 6 and the lower container 7 respectively have flange parts 12a and 12b. Each of the flanges 12a and each of the flanges 12b are attached closely to each other, and then, are fastened by use of clamps 8a and 8b. This realizes a cleaning tank in a sealed state. Note that an O-ring 14 is preferably interposed between each of the flanges 12a and each of the flanges 12b for the purpose of ensuring a highly sealed state.

[0070] In the lower container 7, holding means 9 for holding a cleaning object is disposed. The holding means 9 is capable of holding one or a plurality of cleaning objects.

[0071] Further, a lamp 31 is provided, as heating means, outside the cleaning tank 13. A fluid supply line 20 is connected to the cleaning fluid inlet 11 of the cleaning tank 13.

[0072] Additionally, first, the fluid supply line 20 is connected to an SPM source 22a through a tank 21a, a DHF source 22b through a supply tank 21b, an APM source 22c through a supply tank 21c, an HPM source 22d through a supply tank 21d, and an IPA source 22e through a supply tank 21e. Further, a pressure tank 24, which is for increasing pressures in the cleaning fluid inside each of supply tanks 21a, 21b, 21c, 21d and 21c, is connected to the tanks 21a, 21b, 21c, 21d, and 21e through the pressure line 23. To the pressure tank, a pressurization gas, such as a nitrogen gas, source 25 is connected.

[0073] In addition, secondly, the fluid supply line 20 is connected to a hydrogen gas source (mainly a gas source for hydrogen termination) 26a, a nitrogen gas source 26b, and a chlorine gas source (mainly a gas source for cleaning) 26c.

[0074] Furthermore, thirdly, the fluid supply line 20 is connected to an extra-pure water source 28 is connected through an extra-pure water tank 27

[0075] On the other hand, a discharging line 29 is connected to the cleaning fluid outlet 10, and the discharging line 29 is connected to the vacuum pump 15 through the pressure-reduction tank 14. The cleaning fluid after cleaning is stored in the pressure-reduction tank 14, to which a drain port 30 for discharging the cleaning fluid is provided.

[0076] Next, descriptions will be provided for a cleaning procedure using the cleaning device shown in Fig. 1. The cleaning object 2 is set in the holding means 9 inside the lower container 7.

[0077] Subsequently, each of the flange parts 12a of the upper container 6 and each of the flange parts 12b of the lower container 7 are attached closely to each other with the O-ring 64 interposed therebetween, and the cleaning tank 13 becomes in a sealed state by use of the clamps 8a and 8b.

[0078] Subsequently, with the valves V_{51} and V_{52} opened, with the valve V_{10} closed, with the valve V_{15} is opened, and with the valve V_{16} is closed, vacuuming is performed inside the pressure-reduction tank 14 by use of the vacuum pump 15. By performing

vacuuming of the pressure-reduction tank 14, the inside of the cleaning tank 13 becomes in a pressure-reduced state as well.

[0079] When the inside of the cleaning tank becomes in a predetermined pressure-reduced state, the valve V_{53} is closed, the valve V_{10} is opened, and the valve V_8 is opened. SPM inside the SPM supply tank 21a is sucked into the inside of the cleaning tank 13 through the cleaning fluid inlet 11, whereby cleaning of the cleaning object 2 is performed while the inside of the cleaning tank 13 is filled with SPM. In this respect, a speed of SPM flowing inside the cleaning tank 13 can be controlled by means of adjusting a vacuum speed by the valve V_{15}, and of adjusting a pressure in the pressure tank.

[0080] The SPM after cleaning is introduced to the pressure-reduction tank 14 through the cleaning fluid outlet 10, and is stored inside the pressure-reduction tank 14.

[0081] After the SPM cleaning, with the valve V_8 closed and with the V_{12} opened, while an N_2 gas is caused to flow, the SPM remaining inside the cleaning tank 13 is completely discharged from inside the cleaning tank 13.

[0082] After the completion of discharging of the SPM from inside the cleaning tank 13, the valve V_1 is opened to introduce extra-pure water inside the extra-pure water tank 27 into the cleaning tank 13, whereby rinsing is performed.

[0083] Subsequently, through the same procedure as the SPM cleaning and rinsing, the DHF cleaning and rinsing, the APM cleaning and rinsing, the HPM cleaning and rinsing, and DHF cleaning and rinsing are performed.

[0084] Note that, in a case where a used temperature is not a room temperature, it suffices that the lamp 31 is turned on to heat the cleaning fluid.

[0085] After a completion of the last cleaning by a liquid and rinsing (the DHF cleaning and rinsing which are shown in the lowest row in Table 1), the valve 14 is opened in a state where the discharge and supply lines are inverted, with the valves V_1, V_{10}, and V_{15} closed and with the valves V_{51} and V_{52} opened. In a state where purified water is filled therein, IPA is introduced into the cleaning tank, and the fluid, which has a thin film-like IPA surface on the surface of the purified water, flows down through the outlet 11, whereby similar effects as in the case of the conventional Marangoni drying

can be obtained.

[0086] After drying, the valve V_{11} is opened to introduce hydrogen to the inside of the cleaning tank 13, whereby hydrogen termination processing is performed. Hereinbefore, the processing on the cleaning object 2 is completed.

[0087] After a completion of the processing on the cleaning object 2, all of the valves are closed, and clamps 8a and 8b are removed to separate the upper tank 6 and the lower tank 7. Thereafter, the cleaning object 2 is taken out from the cleaning tank 13. Subsequently, processing on a next cleaning object is performed similarly.

[0088] (Second Embodiment) An example of a second embodiment is shown in Fig. 3. In this example, an aspirator 60 is used as the pressure-reducing means, instead of the vacuum pump 15 shown in Fig. 1. Other aspects are similar as in the case of the first embodiment.

[0089] The aspirator is used as a simple pressure-reducing pump for discharging, and the ultimate pressure is approximately 10 Torr to 30 Torr. In addition, the aspirator can create a clean vacuum without diffusion of oil. Accordingly, this is preferably used in the present invention.

[0090] (Third Embodiment) An example of a third embodiment is shown in Fig. 4. The major different points between this embodiment and the first embodiment are as follows.

[0091] These are (1) a point that purification means 40 for a cleaning fluid after cleaning is provided to a drain port 30 of a pressure-reduction tank 14, and a circulation line 42 for returning the cleaning fluid after purification to a chemical fluid supply tank 50, (2) a point that a pressure-reduction tank cleaning line 45 for cleaning the inside of the pressure-reduction tank 14 is provided, and (3) a point that a trap 44 is provided upstream of the vacuum pump 15.

[0092] Other aspects are similar to the case of the first embodiment. Hereinafter, mainly in terms of the points (1) to (3), detailed descriptions will be provided.

[0093] A filter 40 is provided as purification means to the drain port 30 of the pressure-reduction tank 14. This filter 40 functions for removal of particles and the like which flow in the cleaning fluid after cleaning. After being purified through the filter

40, the cleaning fluid is flown back into the chemical fluid tank 50 through the circulation line 42.

[0094] Note that, although after cleaning, by making the cleaning fluid pass through the filter 40, the particles and the like are removed from the cleaning fluid, the cleaning ability thereof is deteriorated compared to an unused cleaning fluid. Therefore, after the degradation thereof is confirmed by use of a monitor or the like, the cleaning fluid is transferred to a waste fluid tank 48 and is disposed.

[0095] Subsequently, cleaning of the pressure-reduction tank 14 will be described. A vacuum cleaning line 45 is connected to an exit of the pressure-reduction tank 14. On the vacuum cleaning line 45, a purified water circulation pump 52, cleaning purified water tank 53 and a waste purified water tank 54 are provided in this order. To the cleaning purified water tank 53 is a purified water source 55, which supplies purified water to the cleaning purified water tank 53, is connected. A gas-discharging line 56 is connected between the cleaning purified water tank 53 and the waste purified water tank 54.

[0096] After chemical fluid in the pressure-reduction tank 14 is transferred to the chemical fluid supply tank 50, or is drained through the waste chemical fluid tank 48 to be disposed of, purified water is supplied to the cleaning purified water tank 53 through the purified water supply line, and the inside of the tank is cleaned while the purified water is circulated by the purified water circulation pump 52. The purified water after cleaning is transferred to the waste purified water tank 54, and thereafter is drained. This operation is repeated to clean the inside of the pressure-reduction tank 14.

[0097] Note that, it is also possible to enhance throughput by providing a number of pressure-reduction tanks 14, the number corresponding to chemical fluid types, and by switching among valves.

[0098] Next, descriptions will be provided for the embodiment shown in Fig. 4 with respect to an operation method thereof. With V10, V60 and V6 closed, and with V15, V61, V62 and V63 opened, the vacuum pump 15 is operated. Accordingly, insides of the pressure-reduction tank 14, a discharging line 29 and a cleaning tank 13 become in a pressure-reduced state.

[0099] The V60, V62, V63 and V6 are closed, and the V10, V15 and V61 are opened. Since the inside of the cleaning tank 13 is in the pressure-reduced state, chemical fluid flows into the inside of this pressure-reduced cleaning tank 14. Concurrently, the discharging line and the discharging line 29

[0100]

[Example] Subsequently, an example of the present invention will be provided. A cleaning test was carried out by using the cleaning device shown in Fig. 1 and the cleaning device shown in Fig. 5.

[0101] A silicon wafer having a diameter of 8 inch (cleaning object) was prepared and was immersed in fluid of 0.5% hydrofluoric acid (1ppm of $CuCl_2$ added) for ten minutes to cause metal contamination on a surface of the silicon wafer.

[0102] After the above-described immersion, over-flow rinsing using extra-pure water was performed for five minutes, and subsequently, spin-drying was performed.

[0103] This silicon wafer was housed inside the sealed cleaning tank 13 in Fig. 3, and pressure inside the pressure-reduction tank 14 was reduced to be in vacuum at 20 Torr by use of the vacuum pump. Concurrently, a pressurization gas 25 was sent into the pressure tank 24, and SPM was supplied from a SPM supply tank into the cleaning tank 13. After the supply of SPM for a predetermined time, the supply of SPM was finished and SPM inside the cleaning tank 13 was sent into the pressure-reduction tank 14. Thereafter, extra-pure water was supplied from the tank 27 to the inside of the cleaning tank 13 to perform rinsing. Note that the vacuum pump 15 was being operated during the time.

[0104] Subsequently, through the same procedure as that of the SPM cleaning, the DHF cleaning, the APM cleaning, the HMP cleaning and the DHF cleaning were carried out.

[0105] Note that, the valve V16 of the pressure-reduction tank 30 was appropriately opened/closed to drain the cleaning chemical fluid after cleaning in the pressure-reduction tank 14. Thereafter, processing was performed by use of a Cl_2 gas.

[0106] Subsequently, purified water and IPA were supplied to the cleaning tank 13 and drying processing was performed. After the IPA drying, a hydrogen gas was supplied to the cleaning tank 13 and hydrogen termination processing was performed. After the

above procedures, the cleaning tank 13 was opened and the silicon wafer was taken out.

[0107] On the other hand, for comparison, by use of the cleaning device shown in Fig. 5, cleaning was performed on a silicon wafer, which was contaminated with metal through the procedure shown in Fig. 1.

[0108] On examination on residual metals and natural oxide films on the above-described silicon wafers, residual particles and residual metal of the silicon wafer cleaned by use of the cleaning device of Fig. 1 were respectively reduced to one third and one fifth of those of the silicon wafer cleaned by use of the cleaning device of Fig. 5.

[0109]

[Effect of the Invention] According to the present invention, following various effects can be realized.

[0110] (1) Because there is no contact with the atmosphere from the cleaning to the drying, contamination and oxidation can be prevented.

(2) Selection range of cleaning chemical can be increased from a liquid to gas. Various combinations of cleaning methods are possible.

[0111] (3) An increase in flow rate of fluid, an increase in rate of replacement inside the tank, and vacuum drying can be possible by reducing/increasing of pressure, whereby time saving in cleaning can be realized efficiency in chemical fluid replacement, rinsing and drying.

[0112] (4) The removed particles can be discharged to the outside of the tank at a high flow rate, and can be prevented from being attached to the cleaning object again. Consequently, cleaning at high cleanliness can be realized. (5) Ion mist emission is prevented.

[Brief description of the drawings]

[Fig. 1] Fig. 1 is a schematic diagram of a system of a cleaning device according to a first embodiment of the present invention.

[Fig. 2] Fig. 2 is a cross-sectional view showing an example of a cleaning tank of the cleaning device of the present invention.

[Fig. 3] Fig. 3 is a schematic diagram of a system of a cleaning device according to a second embodiment of the present invention.

[Fig. 4] Fig. 3 is a schematic diagram of a system of a cleaning device according to a third embodiment of the present invention.

[Fig. 5] Fig. 5 is a schematic diagram showing a conventional cleaning device.

[Descriptions of Reference Numerals]

1	cleaning fluid,
1a	SPM cleaning tank,
1b	DHD tank,
1c	APM tank,
1d	MHP tank,
1e	DHF tank,
2	cleaning object (wafer),
6	upper container,
7	lower container,
8a, 8b	clamp,
9	holding means,
10	cleaning fluid outlet,
11	cleaning fluid inlet,
12a, 12b	flange,
13	cleaning tank,
14	pressure-reduction tank,
15	pressure-reducing means (vacuum pump),
20	fluid supply line,
21a	SPM supply tank,
21b	DHF supply tank,
21c	APM supply tank,
21d	HPM supply tank,
22a	SPM supply source,
22b	DHF supply source,
22c	APM supply source,
22d	HPM supply source,

24 pressure tank,
25 pressurization gas source,
26a hydrogen gas source,
26b nitrogen gas source,
26c chlorine gas source,
26d source of IPA dissolved in purified water,
27 extra-pure water tank,
28 extra-pure water source,
29 discharging line,
30 drain port,
31 heating means (lamp),
40 purification means of cleaning fluid (filter),
41 circulation pump,
42 circulation line,
44 trap
45 pressure-reduction tank cleaning line,
48 waste purified water tank,
50 chemical fluid supply tank,
52 purified water circulation pump,
53 cleaning purified water tank,
54 waste purified water tank,
55 purified water source,
56 discharging line,
60 pressure-reducing means (aspirator),
64 O-ring

FIG. 1

14	PRESSURE-REDUCTION TANK
	DRAIN
21a	SPM SUPPLY TANK
21b	DHF SUPPLY TANK
21c	APM SUPPLY TANK
21d	HPM SUPPLY TANK
21e	IPA SUPPLY TANK
24	PRESSURE TANK
25	PRESSURIZATION GAS
27	EXTRA-PURE WATER TANK
28	EXTRA-PURE WATER SOURCE

FIG. 2

	DISCHARGING LINE
2	CLEANING OBJECT (WAFER)
6	UPPER CONTAINER
7	LOWER CONTAINER
8a, 8b	CLAMP
9	HOLDING MEANS
10	CLEANING FLUID OUTLET
11	CLEANING FLUID INLET
12a, 12b	FLANGE
13	CLEANING TANK
14	O-RING

Fig. 3

14	PRESSURE-REDUCTION TANK
21a	SPM SUPPLY TANK
21b	DHF SUPPLY TANK
21c	APM SUPPLY TANK
21d	HPM SUPPLY TANK
21e	IPA SUPPLY TANK
24	PRESSURE TANK
25	PRESSURIZATION GAS
27	EXTRA-PURE WATER TANK

28 EXTRA-PURE WATER SOURCE

FIG. 4

TO WASTE FLUID TANK

AIR DISCHARGE

PURIFIED WATER SUPPLY LINE

AIR DISCHARGING LINE

DRAIN

CONCURRENTLY ARRANGE AS CHEMICAL LIQUID SUPPLY LINE AS NECESSARY

14 PRESSURE-REDUCTION TANK

15 PRESSURIZATION GAS DEVICE (SUCH AS N_2)

16 GAS SUPPLY

22 CHEMICAL FLUID

24 PRESSURE TANK

42 CIRCULATION LINE

48 WASTE CHEMICAL FLUID TANK

50 CHEMICAL FLUID SUPPLY TANK

53 COOLING PURIFIED WATER TANK

54 WASTE PURIFIED WATER TANK

FIG. 5

RINSING

FIG. 1

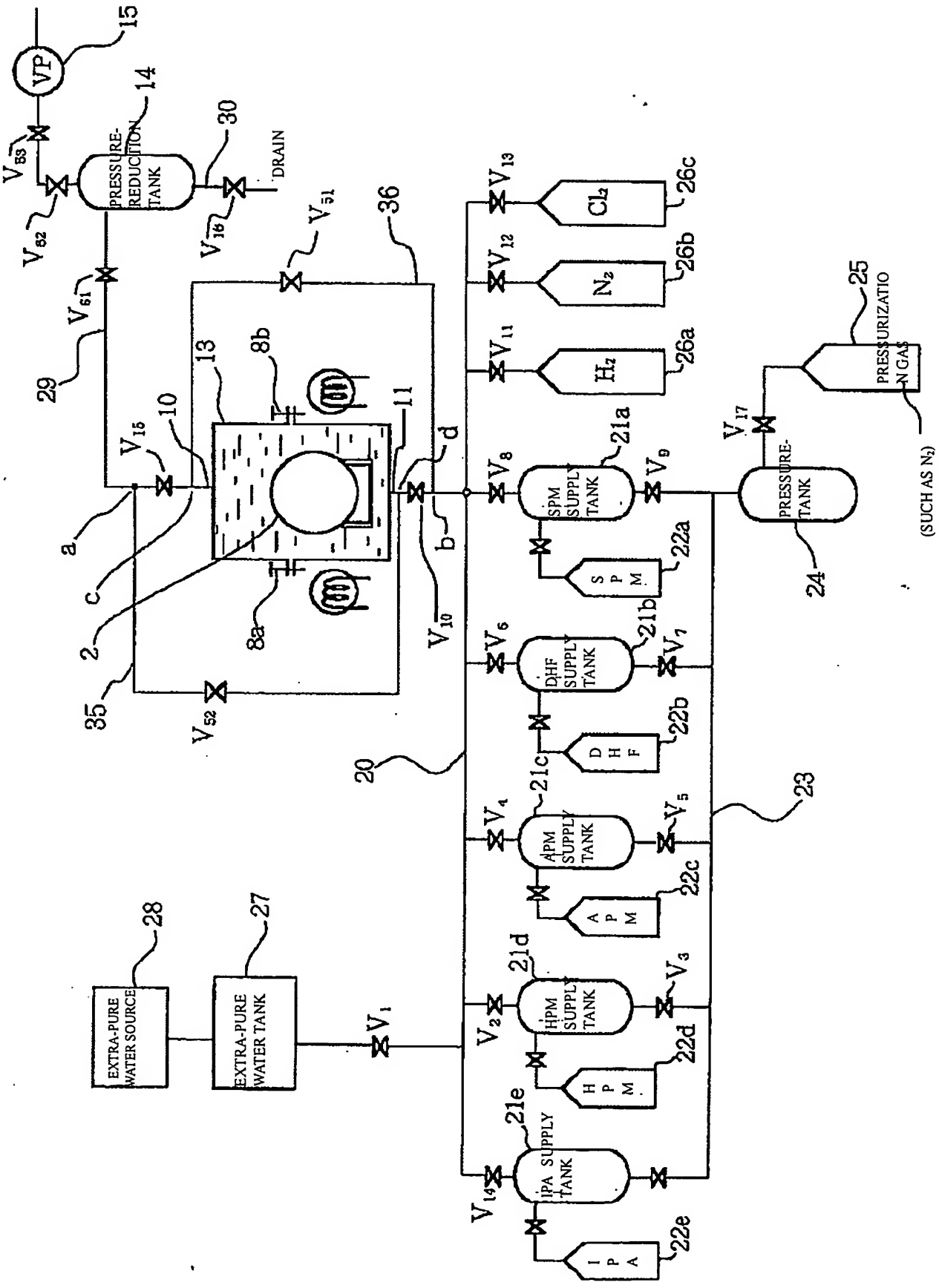
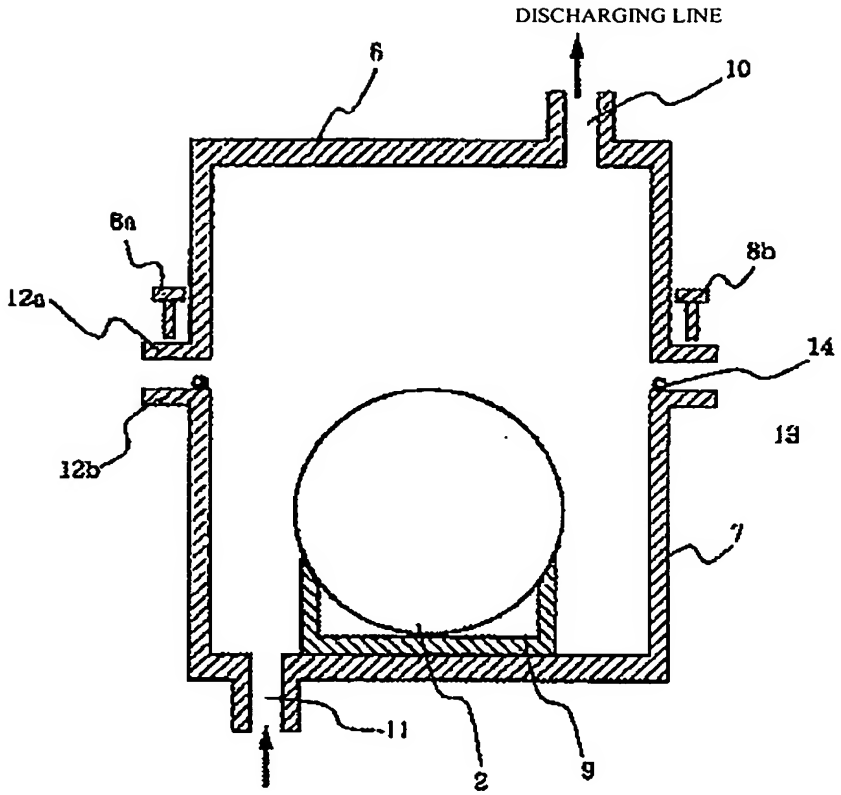

VP
15
14
PRESSURE-REDUCTION TANK
30
DRAIN
V_{53}
V_{52}
V_{16}
V_{61}
29
V_{51}
36
13
8b
10
V_{15}
11
d
a
c
2
b
8a
V_{10}
35
V_{52}
V_{13}
Cl_2
26c
V_{12}
N_2
26b
V_{11}
H_2
26a
25
PRESSURIZATIO N GAS
(SUCH AS N_2)
V_{17}
PRESSURE-TANK
24
V_8
SPM SUPPLY TANK
21a
V_9
S P M
22a
V_6
DHF SUPPLY TANK
21b
V_7
D H F
22b
20
21c
V_4
APM SUPPLY TANK
V_5
23
A P M
22c
28
27
EXTRA-PURE WATER SOURCE
EXTRA-PURE WATER TANK
V_1
V_2
21d
HPM SUPPLY TANK
V_3
H P M
22d
21e
V_{14}
IPA SUPPLY TANK
I P A
22e

FIG. 2



2	CLEANING OBJECT (WAFER)	10	CLEANING FLUID OUTLET
6	UPPER CONTAINER	11	CLEANING FLUID INLET
7	LOWER CONTAINER	12a,12b	FLANGE
8a,8b	CLAMP	13	CLEANING TANK
9	HOLDING MEANS	14	O-RING

FIG. 3

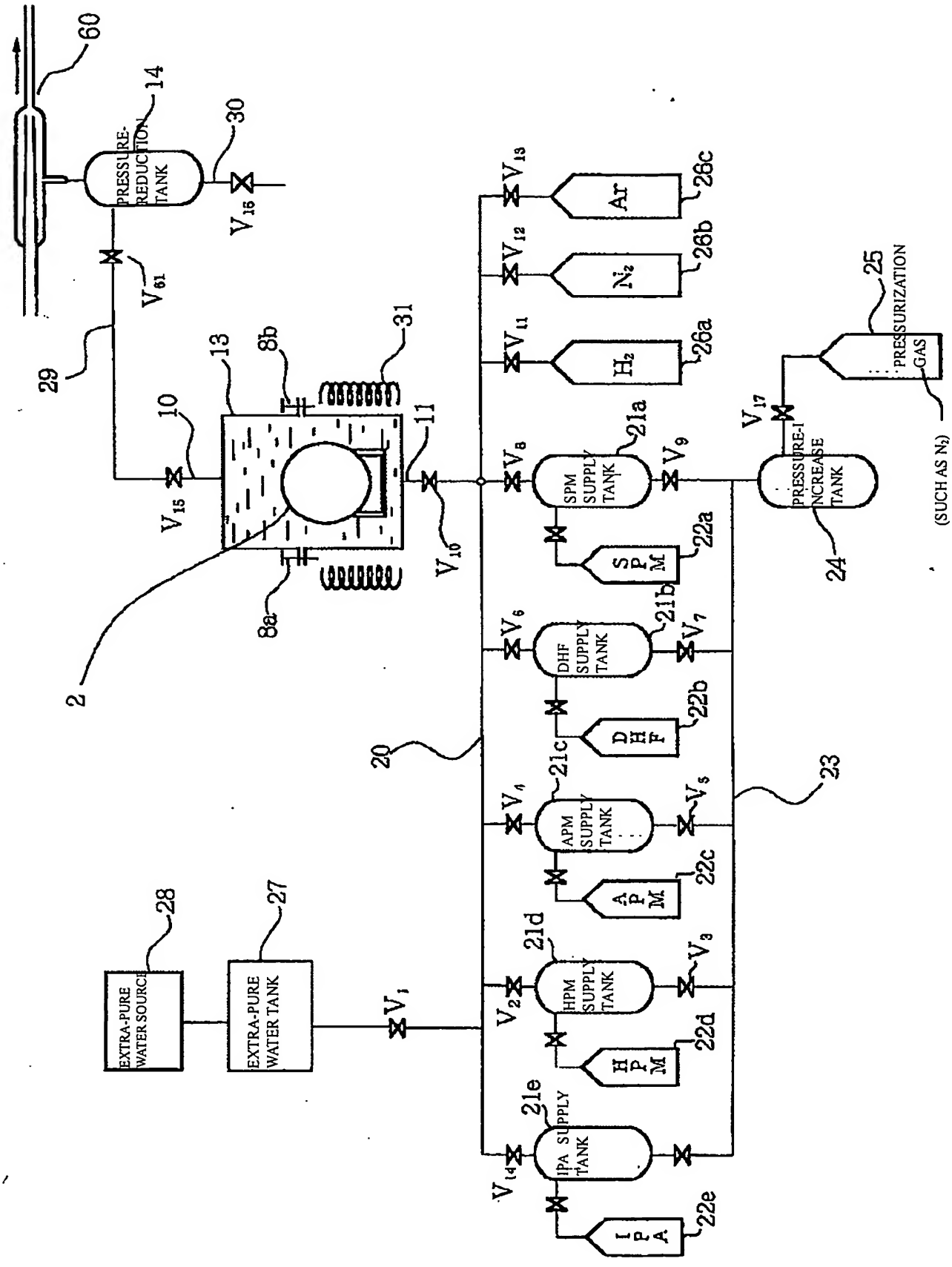

60
PRESSURE-REDUCTION TANK
14
30
V_{16}
V_{61}
29
2
13
8b
31
10
V_{15}
8a
11
V_{10}
V_{13}
Ar
26c
V_{12}
N_2
26b
V_{11}
H_2
26a
25
PRESSURIZATION GAS
(SUCH AS N_2)
V_{17}
PRESSURE-INCREASE TANK
24
V_8
SPM SUPPLY TANK
21a
V_9
SPM
22a
V_6
DHF SUPPLY TANK
21b
V_7
DHF
22b
20
V_4
APM SUPPLY TANK
21c
V_5
23
APM
22c
28
EXTRA-PURE WATER SOURCE
27
EXTRA-PURE WATER TANK
V_1
V_2
HPM SUPPLY TANK
21d
V_3
HPM
22d
V_{14}
IPA SUPPLY TANK
21e
IPA
22e

FIG. 4

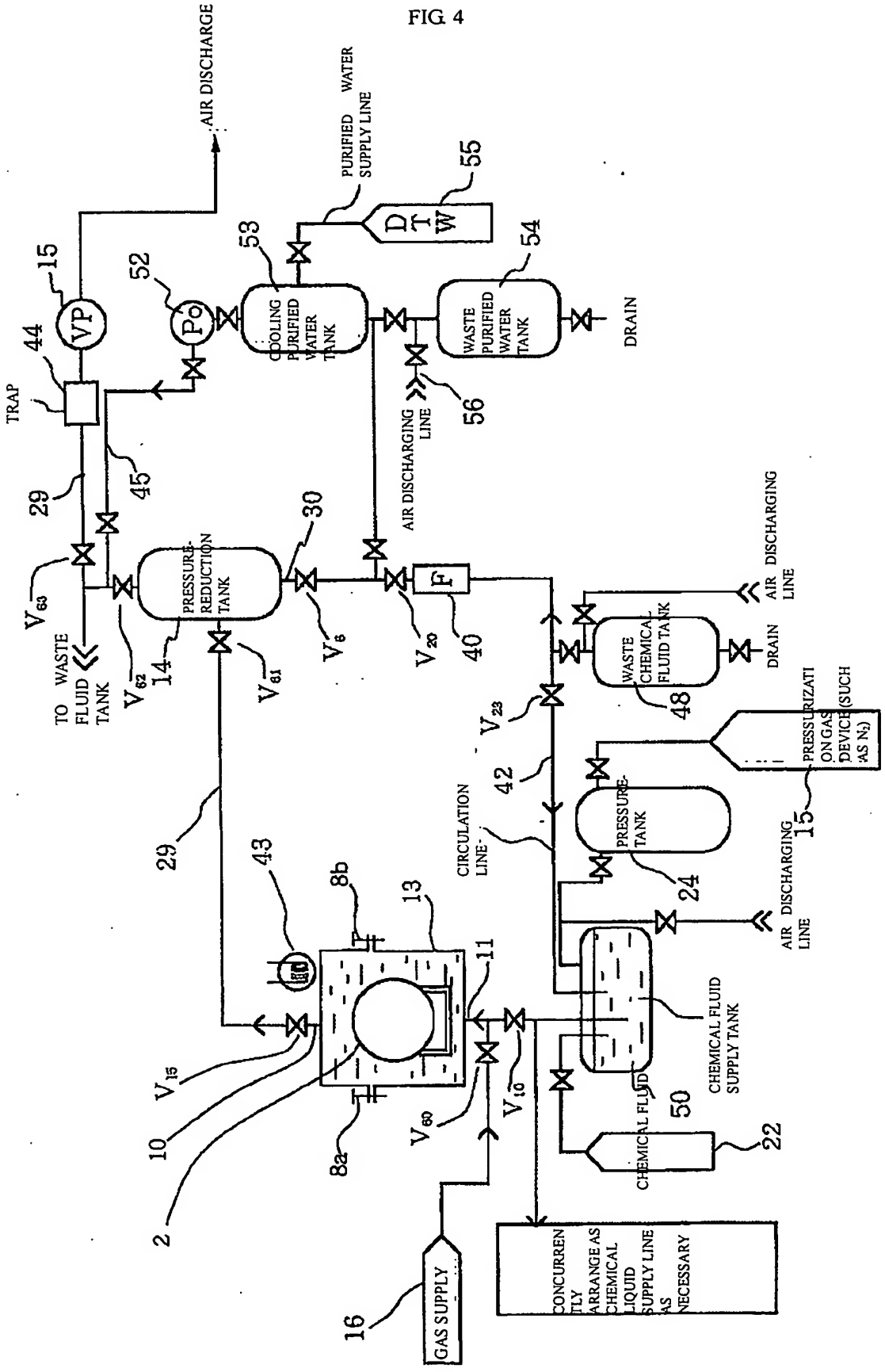
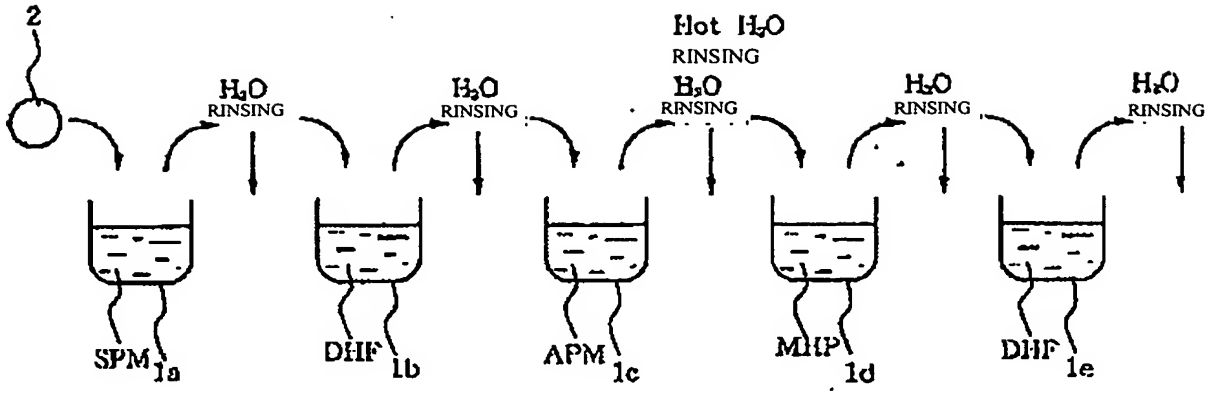

AIR DISCHARGE
PURIFIED WATER SUPPLY LINE
DTW
55
53
COOLING PURIFIED WATER TANK
54
WASTE PURIFIED WATER TANK
DRAIN
52
Po
15
VP
44
TRAP
56
AIR DISCHARGING LINE
29
45
30
PRESSURE-REDUCTION TANK
F
40
AIR DISCHARGING LINE
TO WASTE FLUID TANK
WASTE CHEMICAL FLUID TANK
48
DRAIN
PRESSURIZATION GAS DEVICE (SUCH AS N2)
15
42
CIRCULATION LINE
PRESSURE-TANK
24
AIR DISCHARGING LINE
43
8b
13
11
CHEMICAL FLUID SUPPLY TANK
CHEMICAL FLUID
50
22
10
8a
2
16
GAS SUPPLY
CONCURRENTLY ARRANGE AS CHEMICAL LIQUID SUPPLY LINE AS NECESSARY

FIG. 5


2
H_2O
RINSING
H_2O
RINSING
Hot H_2O
RINSING
H_2O
RINSING
H_2O
RINSING
SPM 1a
DHF 1b
APM 1c
MHP 1d
DHF 1e

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					A
	3/10			3/10	Z

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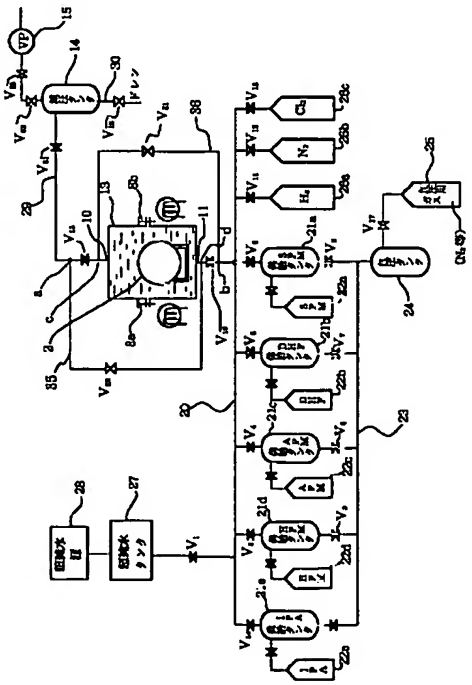
(54)【発明の名称】　完全密閉型気液洗浄装置及び洗浄方法

(57)【要約】
【課題】　本発明は、洗浄効率が良好な洗浄を行うことが可能な完全密閉型気液洗浄装置および洗浄方法を提供することを目的とする。
【解決手段】　本発明の洗浄装置は、内部に洗浄用流体を導入するための洗浄用流体導入口と、内部の洗浄流体を外部へ排出するための洗浄用流体排出口とを有し、内部に被洗浄物を収納後密閉可能な洗浄槽と、前記洗浄用流体排出口に接続され、洗浄後の洗浄用流体を溜めるためのタンクと、該タンクの内部を減圧状態にするための減圧手段と、を有することを特徴とする完全密閉型気液洗浄装置である。



【特許請求の範囲】
【請求項１】　内部に洗浄用流体を導入するための洗浄用流体導入口と、内部の洗浄流体を外部へ排出するための洗浄用流体排出口とを有し、被洗浄物を内部に収納後密閉可能な洗浄槽と、
前記洗浄用流体排出口に接続され、洗浄後の洗浄用流体を溜めるためのタンクと、
該タンクの内部を減圧状態にするための減圧手段と、を有することを特徴とする完全密閉型気液洗浄装置。
【請求項２】　前記洗浄槽は透光性を有する材料からなることを特徴とする請求項１記載の完全密閉型気液洗浄装置。
【請求項３】　前記密閉された洗浄槽内に光を照射するための光照射手段を洗浄槽外に設けたことを特徴とする請求項１または２記載の完全密閉型気液洗浄装置。
【請求項４】　前記洗浄槽内へ導入する洗浄用流体を加圧するための加圧手段を設けたことを特徴とする請求項１ないし３のいずれか１項記載の完全密閉型気液洗浄装置。
【請求項５】　前記洗浄槽内を加熱するための加熱手段を設けたことを特徴とする請求項１ないし４のいずれか１項記載の完全密閉型気液洗浄装置。
【請求項６】　前記加熱手段は、洗浄槽の外部に設けられた赤外線ランプであることを特徴とする請求項１１ないし５のいずれか１項記載の完全密閉型気液洗浄装置。
【請求項７】　前記減圧手段アスピレーターであることを特徴とする請求項１ないし６のいずれか１項記載の完全密閉型気液洗浄装置。
【請求項８】　前記洗浄用流体は液体であることを特徴とする請求項１ないし７のいずれか１項記載の完全密閉型気液洗浄装置。
【請求項９】　前記洗浄用流体は気体であることを特徴とする請求項１ないし７のいずれか１項記載の完全密閉型気液洗浄装置。
【請求項１０】　複数の洗浄用流体源が、前記洗浄用流体導入口にバルブを介して接続されていることを特徴とする請求項１ないし９のいずれか１項記載の完全密閉型気液洗浄装置。
【請求項１１】　前記タンクに溜められた洗浄後の洗浄流体を純化するための純化手段を設けたことを特徴とする請求項１ないし１０のいずれか１項記載の完全密閉型気液洗浄装置。
【請求項１２】　前記純化手段で純化した純化洗浄流体を洗浄流体源へ環流するための環流ラインを設けたことを特徴とする請求項１１記載の完全密閉型気液洗浄装置。
【請求項１３】　前記減圧手段の下流にトラップを設けたことを特徴とする請求項１ないし１２のいずれか１項記載の完全密閉型気液洗浄装置。
【請求項１４】　前記洗浄用流体導入口を内部の洗浄流体を外部へ排出するための口とし、前記洗浄用流体排出口を内部に洗浄用流体を導入するための洗浄用流体導入口するための切替バルブを設けたことを特徴とする請求項１ないし１３のいずれか１項記載の完全密閉型気液洗浄装置。とを有し、被洗浄物を内部に収納後密閉可能な洗浄槽と、
前記洗浄用流体排出口に接続され、洗浄後の洗浄用流体を溜めるためのタンク
【請求項１５】　洗浄槽内に被処理物を装入した後該洗浄槽を密閉化し、
該洗浄槽内と該洗浄槽とラインを介して連通しているタンク内とを排気することにより洗浄槽内、ライン内及び該タンク内を減圧状態とし、
該減圧状態の洗浄槽と薬液供給源とを連通状態とすることにより該薬液を該洗浄槽内に導入することを特徴とする完全密閉型気液洗浄方法。
【請求項１６】　該洗浄槽と該薬液供給源とを連通状態とする際に、該減圧タンク内の排気は停止していることを特徴とする請求項１５記載の完全密閉型気液洗浄方法。
【請求項１７】　該洗浄槽と該薬液供給源とを連通状態とする際に、該減圧タンク内の排気を行っていることを特徴とする請求項１５記載の完全密閉型気液洗浄方法。
【請求項１８】　前記減圧状態は１００Ｔｏｒｒ以下であることを特徴とする請求項１５記載の完全密閉型気液洗浄方法。
【請求項１９】　前記減圧状態は１０Ｔｏｒｒ～１００Ｔｏｒｒであることを特徴とする請求項１８記載の完全密閉型気液洗浄方法。
【請求項２０】　洗浄用流体を加圧して洗浄槽内に導入することを特徴とする請求項１５ないし１９のいずれか１項記載の完全密閉型気液洗浄方法。
【請求項２１】　複数の洗浄工程を順次同一の洗浄槽で行うことを特徴とする請求項１５ないし２０のいずれか１項記載の完全密閉型気液洗浄方法。
【請求項２２】　前記洗浄用流体は液体であることを特徴とする請求項１５ないし２１のいずれか１項記載の完全密閉型気液洗浄方法。
【請求項２３】　前記洗浄用流体は気体であることを特徴とする請求項１５ないし２１のいずれか１項記載の完全密閉型気液洗浄方法。
【発明の詳細な説明】
【０００１】
【産業上の利用分野】本発明は完全密閉型の気液洗浄装置及び洗浄方法に係る。
【０００２】
【従来の技術】超ＬＳＩを例にとり従来の技術を説明する。超ＬＳＩの製造は、金属や絶縁膜等の薄膜をシリコンウエハ全面に形成して必要なパターンのみ残してエッチング除去するという行程の繰り返しにより行われる。

【０００３】最近では凹凸のあるウエハ表面を一旦平坦化するいわゆるＣＭＰ（化学機械研磨）工程を採用する場合もあり、かかるＣＭＰ工程を経たウエハの表面には研磨粉が残留付着しており、この研磨粉の除去は容易ではない。

【０００４】したがって、各工程の前後にはウエハ上の様々な汚染物を取り除くための洗浄工程が必要とされる。

【０００５】各製造プロセス前のウエハには次の条件が要求される。

① パーティクル汚染がないこと
② 金属汚染がないこと
③ 有機物汚染がないこと
④ 水分の吸着がないこと
⑤ 自然酸化膜がないこと
⑥ 原子スケールで表面の凹凸がないこと
⑦ シリコン表面が完全に水素で終端されていること
⑧ 帯電しないこと

である。

【０００６】現在、一般的に使用されている洗浄方法は、過酸化水素水をベースとした薬液によるウエット洗浄方法（ＲＣＡ洗浄）を基に構成されている。一例を表１に示す。

【０００７】

【表１】

洗浄液	混合比	使用温度	洗浄目的物
H_2SO_4/H_2O_2 (SPM)	4:1	120℃	有機物、金属
H_2Oリンス		室温	薬品
HF/H_2O(DHF)	1:100	室温	自然酸化膜
H_2Oリンス		室温	薬品
$NH_4OH/H_2O_2/H_2O$(APM)	1:1:5	70-90℃	粒子、有機物
Hot H_2Oリンス		80℃	薬品
H_2Oリンス		室温	薬品
$HCl/H_2O_2/H_2O$(HPM)	1:1:6	70-90℃	金属
H_2Oリンス		室温	薬品
HF/H_2O(DHF)	1:100	室温	自然酸化膜
H_2Oリンス		室温	薬品

【０００８】かかる洗浄を行う場合は、図５に示すように、バッチおよび枚葉で処理されるウエハ２を、上部が開放しているＳＰＭ洗浄槽１ａに浸漬して洗浄を行い、ＳＰＭ洗浄後ウエハ２をＳＰＭ洗浄槽１ａから大気中に搬送系（図示せず）を用いて取り出し、ＳＰＭの除去を目的として純水リンスを行う。ついで、搬送系を用いて、やはり上部が開放しているＤＨＤ槽１ｂ、ＡＰＭ槽１ｃ、ＭＨＰ槽１ｄ、ＤＨＦ槽１ｅにウエハ２を順次浸漬して洗浄を行う。各洗浄の間においては純水リンスを行う。

【０００９】しかし、上記従来技術には次のような問題点があった。

【００１０】① 一般に、洗浄を行った場合洗浄液と汚染物とが反応して反応生成ガスの発生をもたらす。この反応生成ガスはクリーンルーム内に放出されるとクリーンルーム内を汚染することはいうまでもない。

【００１１】この反応性ガスは洗浄槽内に滞留するとともに洗浄液中に溶解する。しかるに、例えば被洗浄物が大きい場合には反応生成ガスは大量に発生し、洗浄液への飽和溶解度を超えることがある。飽和溶解度を超えると洗浄液と汚染物との反応が進みにくくなりひいては洗浄効率の低下を招いてしまう。

【００１２】さらに、洗浄液が劣化した場合には洗浄液を洗浄槽内からドレインしてドレイン液を廃棄する。廃棄に先立ち公害上の問題からドレイン液の処理を行う必要があるが、従来技術においてはドレイン液は洗浄液と反応生成ガスとが併存した状態であるためその処理が困難である。

【００１３】また、従来技術においてはドレインは大気雰囲気にさらされている槽に直接行うため洗浄槽中にゴミが混入してしまうという問題もある。

【００１４】② 洗浄槽間を移動する度に搬送系により大気中を搬送されるので、大気中のパーティクル、汚染物が被洗浄物（例えばウエハ）２に付着する。

【００１５】また、搬送系における主に摺動部からもダストが発生し、そのダストが被洗浄物であるウエハ２に付着してしまう。

【００１６】③ 洗浄により、パーティクル、ダスト等はウエハ表面から脱離するが、この脱離したパーティクル、ダストは、薬液の流れが穏やかなので、被洗浄物の近傍を遊泳或いは薬液表面を浮遊する。かかるパーティクル、ダスト等が薬液中で、あるいは被洗浄物を薬液槽から引き上げる際に被洗浄物に再付着する場合があった。

【００１７】㉔また、従来の洗浄装置は、上部が開放しているためクリーンルーム内にイオンミストを出していた。

【００１８】そのため、洗浄装置は他の成膜装置から離して配置しなければならず、ひいてはクリーンルーム内における装置のレイアウト設計に制限を受けざるを得なかった。

【００１９】たとえば、レジストを使用する露光装置の近傍には洗浄装置を配置することができず、そのため、露光装置と洗浄装置とは離れた位置に配置せざるを得ない。

【００２０】さらには、このミストがクリーンルーム内に侵入するのを防止するため洗浄装置を通じて多量のクリーンエアを排出する必要がある。そのためには、排気ダクトでの圧損を考慮し、大径ダクトを用いたり、またできる限り短くする必要がある。その結果、洗浄装置のクリーンルームでの設置場所は自由に定めることはできず、排ガス処理装置等との関係で制約を受けることになる。また、大量の排気エア中の薬品蒸気を除去するために、大型の排ガス処理装置（スクラバ）が必要となると共に、排出されるクリーンエアを補うために、大容量の新鮮な空気の取り込みのための空調設備が必要となっていた。

【００２１】このように、従来の洗浄装置は、クリーンルームの設備費及び維持費を押し上げ、しかもクリーンルーム内での設置場所は限られることになる。その結果、個々の半導体製造装置をプロセス上最適な位置関係に配置することはできず、洗浄後の次工程の処理装置までの搬送距離は大きくなり、搬送中の半導体基板のクリーンエアからの汚染等も高性能高集積デバイスを製造する上で問題となっている。

【００２２】たとえば、１６Ｍビットあるいは６４ＭビットＤＲＡＭを月産３００万個程度生産するクリーンルーム工場のスペースは８０×２００m²程度と極めて大型化し、トータルのプロセスステップ数５００ 工程程度のうち２０％程度が洗浄工程である。結果として、全工程を通しての半導体基板の搬送距離は１０ｋｍ近くに及ぶ。また、窒素トンネル、窒素ボックスを通して搬送するクローズドシステムによる場合は表面汚染の抑制はできるものの、搬送経路が長く複雑となり、そのための経費は莫大なものとなるため、実際上実現不可能であった。

【００２３】さらに、現在の排気エア処理装置は、いわゆるスクラバーが広く用いられているが、薬品の種類によっては、微量ではあるが処理しきれず大気に放出されることがある。従って、スクラバーから放出されるガスがクリーンルーム内に取り込まれないように、通常、スクラバーはクリーンルームの新鮮な空気の取り入れ口に対して風下側に設置される。しかし、風向きによっては、新鮮な空気の取り入れ口の風上になる場合もあり、この時は、クリーンルーム内に薬品蒸気が取り込まれ、クリーンルーム内を汚染してしまうことになるため、排気エアは高い排気口を用意して流速を十分速くして空高く排出されているのである。また、前述したように、排気エアの効率を上げるために排気ダクトの経路を考慮すると、クリーンルーム内での洗浄装置の設置場所とスクラバーの設置場所の位置関係も制約を受けることになる。

【００２４】さらに、最近、より高い集積度を達成すべく、化学増感型のレジストが検討され始めているが、このレジストは数１０ｐｐｂと極微量のアンモニアにも敏感に反応してレジスト形状の変化を生じるため、ＲＣＡ洗浄等アンモニアを用いる場合には、アンモニアミストとレジストとが接触しないように細心の注意を払わねばならず、洗浄装置とフォトリソグラフィ装置とを完全に分断して配置する必要が生ずる。

【００２５】以上述べたように、従来の洗浄技術においてはミストをクリーンルーム内に排出するため、クリーンルーム内での洗浄装置の設置場所は限られたものとなる。さらに、洗浄装置で使用する薬品が他工程に及ぼす影響並びに排気エア処理装置との関係で、その設置場所はさらに制約を受ける。その結果、製造プロセスに最適な位置関係、すなわち製造プロセスの順に従うように個々の製造処理装置を配置することはできず、結果として半導体基板の搬送距離が極端に長くなって半導体デバイス生産の高い生産性、高い歩留まりが妨げられるという問題がある。

【００２６】㉕のみならず、従来の洗浄技術においては、上部開放容器であるため、洗浄用流体は液体のみに限られ、洗浄効果のあるガス系の使用は出来なかった。㉖また、ＣＭＰを行った後に表面に付着している研磨粉の完全除去が困難である。

【００２７】

【発明が解決しようとする課題】本発明は、洗浄効率が良好な洗浄を行うことが可能な完全密閉型気液洗浄装置および洗浄方法を提供することを目的とする。

【００２８】本発明は、劣化した洗浄液の処理を容易たらしめる完全密閉型気液洗浄装置および洗浄方法を提供することを目的とする。

【００２９】本発明は、洗浄液の廃棄時に発生する洗浄槽中へのゴミの混入がない完全密閉型気液洗浄装置を提供することを目的とする。

【００３０】本発明は、大気からのパーティクル汚染、メカ部からの発塵による汚染の回避が可能な完全密閉型気液洗浄装置を提供することを目的とする。

【００３１】本発明は、被洗浄物から離脱したパーティクルの再付着の回避が可能な完全密閉型気液洗浄装置を提供することを目的とする。

【００３２】本発明は、ガス系導入による洗浄選択肢を拡大し得る完全密閉型気液洗浄装置を提供することを目

的とする。

【００３３】本発明は、流速のコントロールが可能な完全密閉型気液洗浄装置を提供することを目的とする。

【００３４】本発明は、クリーンルーム内へのミスト流出の防止が可能な完全密閉型気液洗浄装置を提供することを目的とする。

【００３５】本発明は、ミストがクリーンルーム内へ放出することを抑えることが可能な洗浄技術方法を確立し、これにより半導体製造装置を略々プロセス順に配置することにより高集積・高性能半導体デバイス生産に適した半導体基板の全工程を通しての搬送距離が最短になし得る（ウエハフローパスミニマム）洗浄装置を提供することを目的とする。

【００３６】さらに、半導体製造の生産性を極めて高くし、工場のランニングコストを大幅に削減でき、且つ設計の自由度が大幅に向上させることが可能な洗浄装置を提供することを目的とする。

【００３７】

【課題を解決するための手段】本発明の洗浄装置は、内部に洗浄用流体を導入するための洗浄用流体導入口と、内部の洗浄流体を外部へ排出するための洗浄用流体排出口とを有し、内部に被洗浄物を収納後密閉可能な洗浄槽と、前記洗浄用流体排出口に接続され、洗浄後の洗浄用流体を溜めるためのタンクと、該タンクの内部を減圧状態にするための減圧手段と、を有することを特徴とする完全密閉型気液洗浄装置である。

【００３８】本発明の洗浄方法は、洗浄槽内に被処理物を装入した後該洗浄槽を密閉化し、該洗浄槽内と該洗浄槽とラインを介して連通している減圧タンク内とを排気することにより洗浄槽内、ライン内及び該減圧タンク内を減圧状態とし、該減圧状態の洗浄槽と薬液供給源とを連通状態とすることにより該薬液を該洗浄槽内に導入することを特徴とする完全密閉型気液洗浄方法である。

【００３９】本発明では、洗浄槽内部は被洗浄物の収納後は密閉され、かつ、減圧手段により減圧状態に保持されるため、大気からのパーティクル汚染がない。

【００４０】また、ＲＣＡ洗浄のような複数の洗浄液を使用した洗浄であっても、同一の洗浄槽に順次複数の洗浄液を導入することにより被洗浄物の搬送を行う必要がないため必然的に搬送系が不要となり、ひいては搬送系のメカ部からの発塵による汚染の回避が可能となる。

【００４１】洗浄液は、洗浄用流体導入口から洗浄槽内部に導入するとともに洗浄用流体排出口から排出しており、洗浄用流体は絶えず流動している。従って、洗浄により被洗浄物から離脱したパーティクルは洗浄用流体排出口から即座に系外に排出されてしまい、そのため、被洗浄物から離脱したパーティクルの再付着の回避が可能となる。

【００４２】さらに、本発明の洗浄装置は密閉されているため、液体のみならず気体をも洗浄に用いることができ、洗浄選択肢を拡大し得る。

【００４３】また、本発明の洗浄装置は、密閉されているため、クリーンルーム内へのミスト流出がない。その結果、洗浄装置の配置の自由度が増すとともに高集積・高性能半導体デバイス生産に適した半導体基板の全工程を通しての搬送距離が最短になし得る。のみならず、ミスト発生にともなうクリーンルーム内のクリーンエアの排出が不要となる。

【００４４】さらに、本発明の洗浄装置では、洗浄用流体は絶えず流れており、常に新しい洗浄用流体で被洗浄物を洗浄することとなり、高い洗浄効率を達成することができる。

【００４５】㊀なお、本発明においては、洗浄槽を透光性材料により構成し、密閉された洗浄槽内に光を照射するための光照射手段を洗浄槽外に設けることが好ましい。ここで光としては赤外線、紫外線、可視光など用途に応じて適宜選択すればよい。

【００４６】たとえば、洗浄槽内に酸素ガスを導入し、酸素に紫外線を照射することによりオゾンを発生させて被洗浄物から有機物を除去することが可能となる。

【００４７】また、赤外線を照射することにより汚染を生ずることなく洗浄用流体の加熱を行うことが可能となる。本発明では加熱機能は光照射で行うことで汚染のない加熱が可能となる。

【００４８】㊁本発明においては、洗浄槽内へ導入する洗浄用流体を加圧するための加圧手段を設けることが好ましい。

【００４９】洗浄槽へ導入する洗浄用流体、特に洗浄用液体を加圧手段により適宜の圧力に加圧すると洗浄用流体の導入流速を制御することができる。洗浄用流体の流速は洗浄効率にも影響を与えるため圧力を制御することにより最適な洗浄効率を得ることができる。

【００５０】㊂本発明においては、浄槽内を加熱するための加熱手段を設けることが好ましい。

【００５１】例えば表１に示す洗浄工程にあっては洗浄液を加熱する場合がある。そのため、外部ヒータ、内部ヒータなどの加熱手段を設けておけば洗浄流体の加熱が可能となる。

【００５２】㊃本発明では、複数の洗浄用流体源を洗浄用流体導入口にバルブを介して接続することにより効果がより一層発揮される。洗浄は表１に示すように複数の異なる薬液を用いて複数の工程をたどって行われる。従来の工程では洗浄を行う場合は、各工程間において必然的に被洗浄物は大気に晒されるし、また、工程間の搬送を行わざるを得ない。

【００５３】しかるに、本発明では、複数の工程が一つの洗浄槽において搬送を行うことなく洗浄を行うことができるため、より一層有効性が発揮される。

【００５４】㊄本発明においては、タンクに溜められた洗浄後の洗浄流体を純化するための純化手段を設けるこ

とが好ましい。

【００５５】◎本発明では減圧手段を設けているが、滑浄な減圧状態を得る手段としてアスピレータの使用が好ましい。

【００５６】次に本発明の洗浄方法を図４を用いて説明する。本発明の洗浄方法においては、まず浄槽１３内に被処理物２を装入した後洗浄槽１３内を密閉化し大気と遮断する。

【００５７】次に、洗浄槽１３内と洗浄槽１３とライン（排出ライン）２９を介して連通している減圧タンク１４内とを排気することにより洗浄槽１３内、ライ２９ン内及び減圧タンク１４内を減圧状態とする。なお、この際、バルブＶ１０，Ｖ６０，Ｖ６は閉、バルブＶ１５，Ｖ６１，Ｖ６２，Ｖ６３はそれぞれ開としておく。また、排気は例えば真空ポンプ、アスピレータ等の排気手段１５により行えばよい。

【００５８】次に、減圧状態の洗浄槽１３と薬液供給源とを連通状態とする。これはバルブＶ１０を開とすることにより行えばよい。洗浄槽１３と薬液供給源とを連通状態とすると、洗浄槽１３、ライン２９、減圧タンク１４内は減圧状態であるため、薬液は洗浄槽１３内に流れ込むとともに、ライン２９を介してさらに減圧タンク１４内にも流れ込む。これにより流動状態の薬液が得られ、かかる流動状態の薬液により被洗浄物２の洗浄が行われる。また、洗浄時に発生する反応生成ガスは発生するとともにライン２９を介して減圧タンク１４内に排気されてしまう。従って、薬液中への反応生成ガスの溶解による江洗浄効率の劣化ということはなく、高効率の洗浄を行うことが可能となる。

【００５９】のみならず、洗浄後の薬液は減圧ポンプに排出されるため薬液交換による洗浄槽内へのパーティクル等の混入という問題も発生しない。

【００６０】なお、洗浄槽１３と薬液供給源とを連通状態にする際（すなわち洗浄時）には、バルブＶ６２を閉とし減圧タンク１４内（ひいては洗浄槽１３）の排気を行わない状態とする場合と、排気を行う場合とのどちらでもよい。前者の場合洗浄後バルブＶ６２を開として減圧タンク１４内の上部に溜まっているガスを排気した後薬液をドレインすればよい。また、後者の場合、排気量を大きくしすぎると薬液が真空ポンプにひかれてしまうため、かかる状態が生じない程度の真空度に排気すればよい。

【００６１】薬液による洗浄後は被洗浄物２はそのままにして薬液による洗浄と同様の手順で連続的にリンス等を行う。

【００６２】薬液による洗浄、リンス等の全洗浄工程が終了後は、バルブＶ６０を開とし、カバーガス（窒素ガスなど）を導入し、洗浄槽１３内を大気圧として洗浄槽の開放する。けだし、洗浄工程終了時点では洗浄槽１３内は減圧状態となっているためである。

【００６３】なお、薬液の代わりにガスで連続洗浄を行う場合はバルブＶ６２，Ｖ６３を開として適宜のトラップ４４を用いればよい。

【００６４】なお、前記減圧状態は１００Ｔｏｒｒ以下が好ましく、１０Ｔｏｒｒ～１００Ｔｏｒｒがより好ましい。

【００６５】

【発明の実施の形態】（第１の形態）図１および図２に基づき本発明の洗浄装置の実施の形態を説明する。なお、本形態はＲＣＡ洗浄を例に挙げて説明するが、本発明はＲＣＡ洗浄にとらわれることはない。

【００６６】本形態では、内部に洗浄用流体１を導入するための洗浄用流体導入口１１と、内部の洗浄用流体１を外部へ排出するための洗浄用流体排出口１０とを有し、内部に被洗浄物２を収納後密閉可能な洗浄槽１３と、洗浄用流体排出口１０に接続され、洗浄後の洗浄用流体を溜めるためのタンク（減圧タンク）１４と、タンク１４の内部を減圧状態にするための減圧手段（真空ポンプ）と、を有している。

【００６７】なお、Ｖ１５は洗浄用流体排出口１０の下流側に設けられたバルブであり、V_{10}は洗浄用流体導入口１１の上流に設けられたバルブである。図２に洗浄槽１３の詳細な構成例を示す。

【００６８】洗浄槽１３は上容器６と下容器７とから構成されている。上容器６の上部には洗浄用流体排出口１０が形成されており、下容器７には洗浄用流体導入口１１が形成されているが、バルブV_{51}，V_{52}の切り換えにより機能を変え可能とすることが好ましい。すなわち、バルブV_{15}の下流の点ａとバルブV_{10}の上流側の点ｄとをバルブV_{52}を有するライン３５で結び、バルブV_{15}の上流の点ｃとバルブＶ１０の下流側の点ｂとをバルブV_{51}を有するライン３６で結んでおけば必要に応じて洗浄用排出口１１から洗浄用流体を洗浄槽１３内に導入することができ、また、洗浄用流体導入口１０から洗浄用流体を洗浄槽１３内から排出することが可能となる。

【００６９】また、上容器６および下容器７はそれぞれフランジ部１２ａ，１２ｂを有している。上容器６と下容器７とをそれぞれのフランジ部１２ａとフランジ１２ｂとを密着させて止め具８ａ，８ｂにより締め付けることにより密閉状態の洗浄槽にすることができる。なお、より高度の密閉性を確保するためにＯリング１４をフランジ部１２ａとフランジ部１２ｂとの間に介在せしめることが好ましい。

【００７０】下容器７内には被洗浄物を保持するための保持手段９が配置されている。保持手段９には１枚あるいは複数枚の被洗浄物を保持させることができる。

【００７１】また、洗浄槽１３の外部には加熱手段としてランプ３１が設けられている。洗浄槽１３の洗浄用流体導入口１１には流体供給ライン２０が接続されている。

【００７２】そして、この流体供給ライン２０には、第１に、タンク２１ａを介してＳＰＭ源２２ａと、供給タンク２１ｂを介してＤＨＦ源２２ｂと、供給タンク２１ｃを介してＡＰＭ源２２ｃと、供給タンク２１ｄを介してＨＰＭ源２２ｄと、供給タンク２１ｅを介してＩＰＡ源２２ｅが接続されている。さらに、各供給タンク２１ａ，２１ｂ，２１ｃ，２１ｄ，２１ｅ内の洗浄用流体を加圧するための加圧タンク２４が加圧ライン２３を介してタンク２１ａ，２１ｂ，２１ｃ，２１ｄ，２１ｅに接続されている。加圧タンクには、例えば窒素ガスなどの加圧用ガス源２５が接続されている。

【００７３】そして、流体供給ライン２０には、第２に、水素ガス源（主に水素終端用ガス源）２６ａ、窒素ガス源２６ｂ、塩素ガス源（主に洗浄用ガス源）２６ｃが接続されている。

【００７４】さらに、流体供給ライン２０には、第３に、超純水タンク２７を介して超純水源２８が接続されている。

【００７５】一方、洗浄槽１３の洗浄用流体排出口１０には、排出ライン２９が接続され、排出ライン２９は減圧タンク１４を介して真空ポンプ１５に接続されている。減圧タンク１４には、洗浄後の洗浄用流体が溜められそれを排出するためのドレイン口３０が設けられている。

【００７６】次に図１に示す洗浄装置を用いた洗浄手順を説明する。下容器７内の保持手段９に被洗浄物２をセットする。

【００７７】ついで、上容器６のフランジ部１２ａと下容器７のフランジ部１２ｂとをＯリング６４を介在させて密着させ留め具８ａ，８ｂにより洗浄槽１３を密閉状態とする。

【００７８】ついでバルブV_{51}、V_{52}を開、バルブV_{10}を閉、バルブV_{15}を開、バルブV_{16}を閉として真空ポンプ１５により減圧タンク１４内の真空引きを行う。減圧タンク１４の真空引きを行うことにより洗浄槽１３内も減圧状態となる。

【００７９】洗浄槽内が所定の減圧状態となったところでバルブV_{53}を閉、バルブV_{10}を開、バルブV_8を開とする。ＳＰＭ供給タンク２１ａ内のＳＰＭは洗浄用流体導入口１１を介して洗浄槽１３内へ吸い上げられ、洗浄槽１３内を満たしつつ被洗浄物２の洗浄が行われる。この際、バルブV_{15}による排気速度を調整することと加圧タンクの圧力を調整することにより洗浄槽１３内を流れるＳＰＭの速度を制御することができる。

【００８０】洗浄後のＳＰＭは洗浄用流体排出口１０を介して減圧タンク１４に導かれ、減圧タンク１４内に貯蔵される。

【００８１】ＳＰＭ洗浄後はバルブV_8を閉としてV_{12}を開いてN_2ガスを流しながら洗浄槽１３内に残存しているＳＰＭを洗浄槽１３内から完全に排出する。

【００８２】ＳＰＭを洗浄槽１３内から排出し終わったら、バルブV_1を開として超純水タンク２７内の超純水を洗浄槽１３内に導入することによりリンスを行う。

【００８３】ついで、ＳＰＭ洗浄、リンスと同様の手順でＤＨＦ洗浄、リンス、ＡＰＭ洗浄リンス、ＨＰＭ洗浄、リンス、ＤＨＦ洗浄、リンスを行う。

【００８４】なお、使用温度が室温でない場合にはランプ３１をオンにして洗浄液の加熱を行えばよい。

【００８５】液体による最後の洗浄、リンス（表１に示す最下段に掲げるＤＨＦ洗浄、リンス）の終了後、バルブV_1、V_{10}、V_{15}を閉とし、バルブV_{51}、V_{52}を開とし、排出、供給ラインを逆にした状態でバルブV_{14}を開とする。純水が満たされた状態でＩＰＡを洗浄槽内に導入し、純水表面に薄膜状に形成されたＩＰＡ面を排水口１１から液を下降させることで従来のマランゴニ乾燥と同等の効果を得ることが可能となる。

【００８６】乾燥後、バルブV_{11}を開として水素を洗浄槽１３内に導入して水素終端を行う。以上で被洗浄物２への処理を終了する。

【００８７】被洗浄物２への処理終了後は、全てのバルブを閉とし、留め具８ａ，８ｂをはずし換え容器６と下容器７とを分離後被洗浄物２を洗浄槽１３から取り出す。ついで次の被洗浄物の処理を同様に行う。

【００８８】（第２の形態）第２の形態例を図３に示す。本例では減圧手段として、図１に示す真空ポンプ１５の代わりにアスピレータ６０を用いている。他の点は第１の形態と同様である。

【００８９】アスピレータは簡単な排気用減圧ポンプとして用いられ、到達真空度はほぼ１０Ｔｏｒｒ～３０Ｔｏｒｒである。また、アスピレータは油の拡散のない清浄な真空を作ることが出来る。ため本発明においては好適に用いることができる。

【００９０】（第３の形態例）図４に第３の形態例を示す。第１の形態との主な相違点は次の通りである。

【００９１】① 減圧タンク１４のドレイン口３０に洗浄後の洗浄用流体の純化手段４０を設けるとともに純化後の洗浄用流体を薬液供給タンク５０に戻すための環流ライン４２を設けた点、

② 減圧タンク１４内を洗浄するための減圧タンク洗浄ライン４５を設けた点、

③ トラップ４４を真空ポンプ１５の上流に設けた点、

である。

【００９２】他の点は第１の実施の形態と同様である。以下、①～③の点をメインに本形態をより詳細に説明する。

【００９３】減圧タンク１４のドレイン口３０には、純化手段としてフィルタ４０が設けられている。このフィルタ４０は、洗浄後の洗浄用流体中に浮遊するパーティクル等を除去する役割を果たす。フィルター４０において純化された後環流ライン４２を通って薬液タンク５０

に環流される。

【００９４】なお、フィルター４０を通すことにより、洗浄後の洗浄用流体からパーティクル等は除去されるが洗浄能力は未使用の洗浄用流体に比べると劣化しているため、モニタ等で劣化が確認された後、廃液タンク４８に移送され廃棄される。

【００９５】次に、減圧タンク１４の洗浄について説明する。減圧タンク１４の出口には、真空洗浄ライン４５が接続されている。真空洗浄ライン４５上には、純水循環ポンプ５２，洗浄用純水タンク５３、純水廃液タンク５４が順に設けられている。洗浄用純水タンク５３には洗浄用純水タンク５３に供給する純水の純水源５５が接続されている。なお、洗浄用純水タンク５３と純水廃液タンク５４との間には排気ライン５６が接続されている。

【００９６】減圧タンク１４の薬液を薬液供給タンク５０に移送するか、薬液廃液タンク４８を介して廃棄した後、純水供給ラインから洗浄用純水タンク５３に純水を供給し、純水循環ポンプ５２で循環しながらタンク内部を洗浄する。洗浄後の純水は純水廃液タンク５４に移送しドレンする。この操作を繰り返し、減圧タンク１４の内部を洗浄する。

【００９７】尚、減圧タンク１４を薬液の種類に対応した数設けてバルブ切り換えによりスループットを上げることも可能である。

【００９８】次に、図４に示す形態を操作方法の観点から説明する。Ｖ１０，Ｖ６０，Ｖ６を閉、Ｖ１５，Ｖ６１，Ｖ６２，Ｖ６３を開として真空ポンプ１５を作動させ、減圧タンク１４、排出ライン２９、洗浄槽１３の内部をを減圧状態にする。

【００９９】Ｖ６０，Ｖ６２，Ｖ６３，Ｖ６を閉、Ｖ１０，Ｖ１５，Ｖ６１を開とする。洗浄槽１３内は減圧状態であるため薬液はこの減圧された洗浄槽１４内に流れる。とともに、排出ライン、排出ライン２９

【０１００】

【実施例】次に本発明の実施例を述べる。図１に示す洗浄装置および図５に示す洗浄装置を用いて洗浄試験を行った。

【０１０１】８インチ径のシリコンウエハ（被洗浄物）を用意し、このシリコンウエハをフッ酸０．５％（$CuCl_2$　１ｐｐｍ添加）液中に１０分間浸漬してシリコンウエハ表面に金属汚染を与えた。

【０１０２】上記浸漬後、超純水によるオーバーフローリンスを５分間行い、ついでスピンドライ乾燥を行った。

【０１０３】このシリコンウエハを図１の洗浄槽１３内に密閉収納し、真空ポンプにより２減圧タンク１４を２０Ｔｏｒｒに真空引きするとともに、加圧用ガス２５を加圧タンク２４に送り込みＳＰＭ供給タンクからＳＰＭを洗浄槽１３に供給した。所定時間供給後、ＳＰＭの供給を停止し、洗浄槽１３内におけるＳＰＭを減圧タンク１４に送りこんだ後、タンク２７から超純水を洗浄槽１３内に供給してリンスを行った。なお、この間真空ポンプ１５は駆動させたままである。

【０１０４】ついで、ＳＰＭ洗浄と同様の手順でＤＨＦ洗浄、ＡＰＭ洗浄、ＨＰＭ洗浄、ＤＨＦ洗浄を行った。

【０１０５】なお、適宜減圧タンク３０のバルブＶ１６を開閉して減圧タンク１４内における洗浄後の洗浄用薬液をドレインした。その後Cl_2ガスにより処理を行った。

【０１０６】ついで、純水とＩＰＡを洗浄槽１３に供給し乾燥を行った。ＩＰＡ乾燥後、水素ガスを洗浄槽１３に供給し、水素終端を行った。以上の手順後洗浄槽１３を開放してシリコンウエハを取り出した。

【０１０７】一方、比較のため図５に示す洗浄装置を用いて、表１に示す手順で金蔵汚染させたシリコンウエハの洗浄を行った。

【０１０８】上記シリコンウエハにつき残留金属と自然酸化膜について調べたところ、図１の洗浄装置を用いて洗浄を行ったシリコンウエハは、図５の洗浄装置を用いて洗浄を行ったシリコンウエハに比べて残留パーティクルは1／3に、残留金属は１／５に減少した。

【０１０９】

【発明の効果】本発明によれば次の諸々の効果が達成される。

【０１１０】㋑洗浄から乾燥まで大気に触れないため汚染、酸化を防げる。

㋺洗浄薬として液体から気体まで選択範囲が広くなる。多くの洗浄方法の組み合わせが可能となる。

【０１１１】㋩加圧、減圧による流体のスピードアップ、槽内置換のスピードアップ、真空乾燥等が可能となり薬液交換、リンス、乾燥の効率化による洗浄時間の短縮が達成される。

【０１１２】㋥除去したパーティクルを高流速にて槽外に排出でき、被洗浄物への再付着を防止することができ、ひいては高い清浄度の洗浄が達成できる。㋭イオンミストの流出が防止される。

【図面の簡単な説明】

【図１】本発明の第１の実施の形態に係る洗浄装置のシステム概念図である。

【図２】本発明における洗浄装置における洗浄槽の一例を示す断面図である。

【図３】本発明の第２の実施の形態に係る洗浄装置のシステム概念図である。

【図４】本発明の第３の実施の形態に係る洗浄装置のシステム概念図である。

【図５】従来の洗浄装置を示す概念図である。

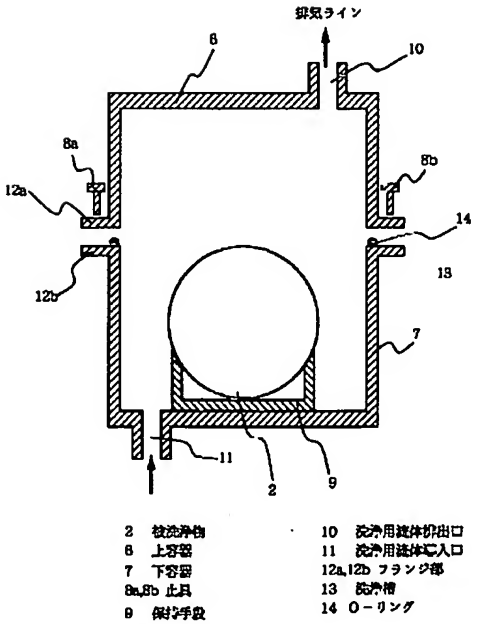
【符号の説明】

１　洗浄用流体、

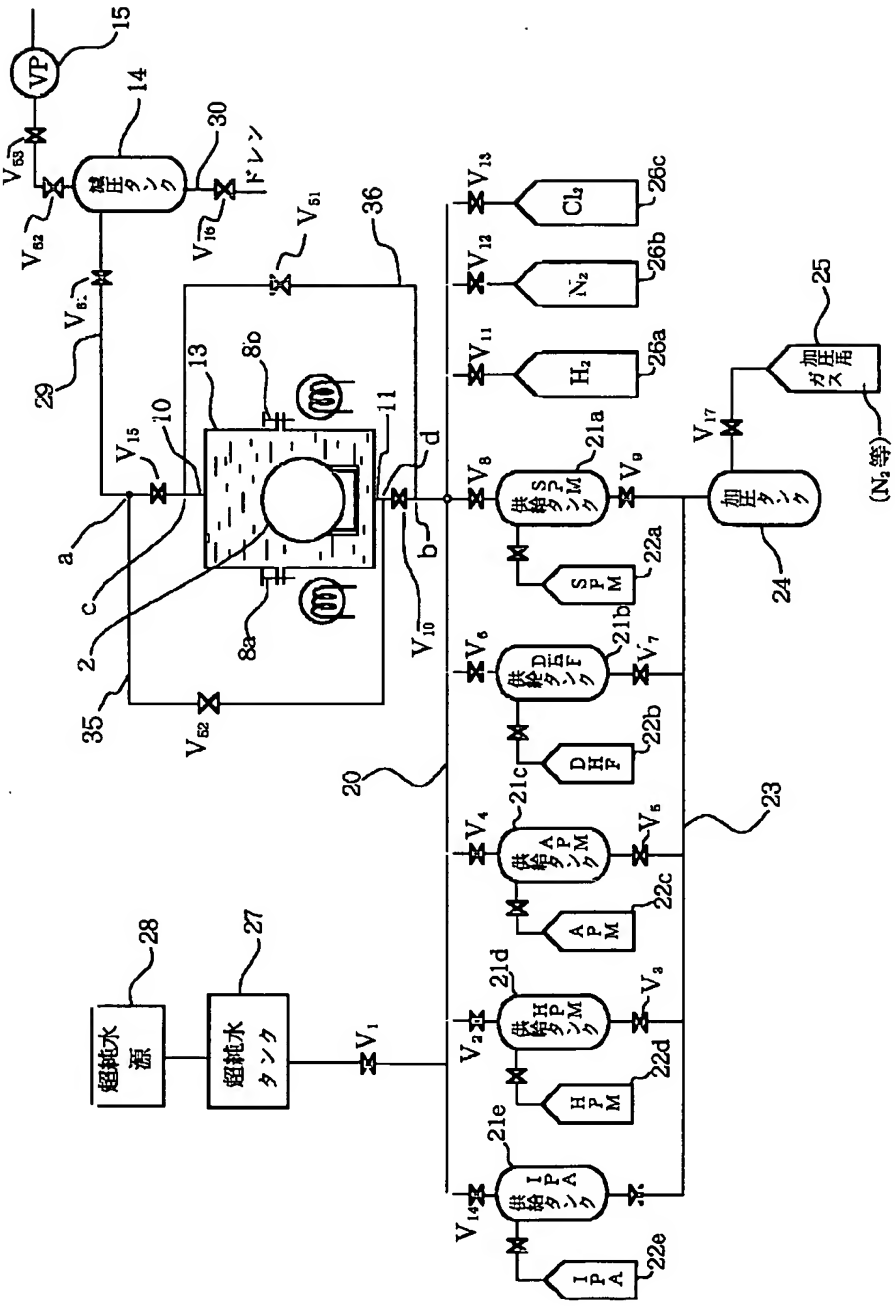
１ａ　ＳＰＭ洗浄槽、

1b　DHD槽、
1c　APM槽、
1d　MHP槽、
1e　DHF槽、
2　被洗浄物（ウエハ）、
6　上容器、
7　下容器、
8a，8b止め具、
9　保持手段、
10　洗浄用流体排出口、
11　洗浄用流体導入口、
12a，12b　フランジ部、
13　洗浄槽、
14　減圧タンク、
15　減圧手段（真空ポンプ）、
20　流体供給ライン、
21a　SPM供給タンク、
21b　DHF供給タンク、
21c　APM供給タンク、
21d　HPM供給タンク、
22a　SPM供給源、
22b　DHF供給源、
22c　APM供給源、
22d　HPM供給源、
24　加圧タンク、
25　加圧用ガス源、
26a　水素ガス源、
26b　窒素ガス源、
26c　塩素ガス源、
26d　純水に溶解したIPA源、
27　超純水タンク、
28　超純水源、
29　排出ライン、
30　ドレイン口、
31　加熱手段（ランプ）、
40　洗浄用流体の純化手段（フィルタ）、
41　循環ポンプ、
42　環流ライン、
44　トラップ、
45　減圧タンク洗浄ライン、
48　純水廃液タンク、
50　薬液供給タンク、
52　純水循環ポンプ、
53　洗浄用純水タンク、
54　純水廃液タンク、
55　純水源、
56　排気ライン、
60　減圧手段（アスピレータ）、
64　Oリング。

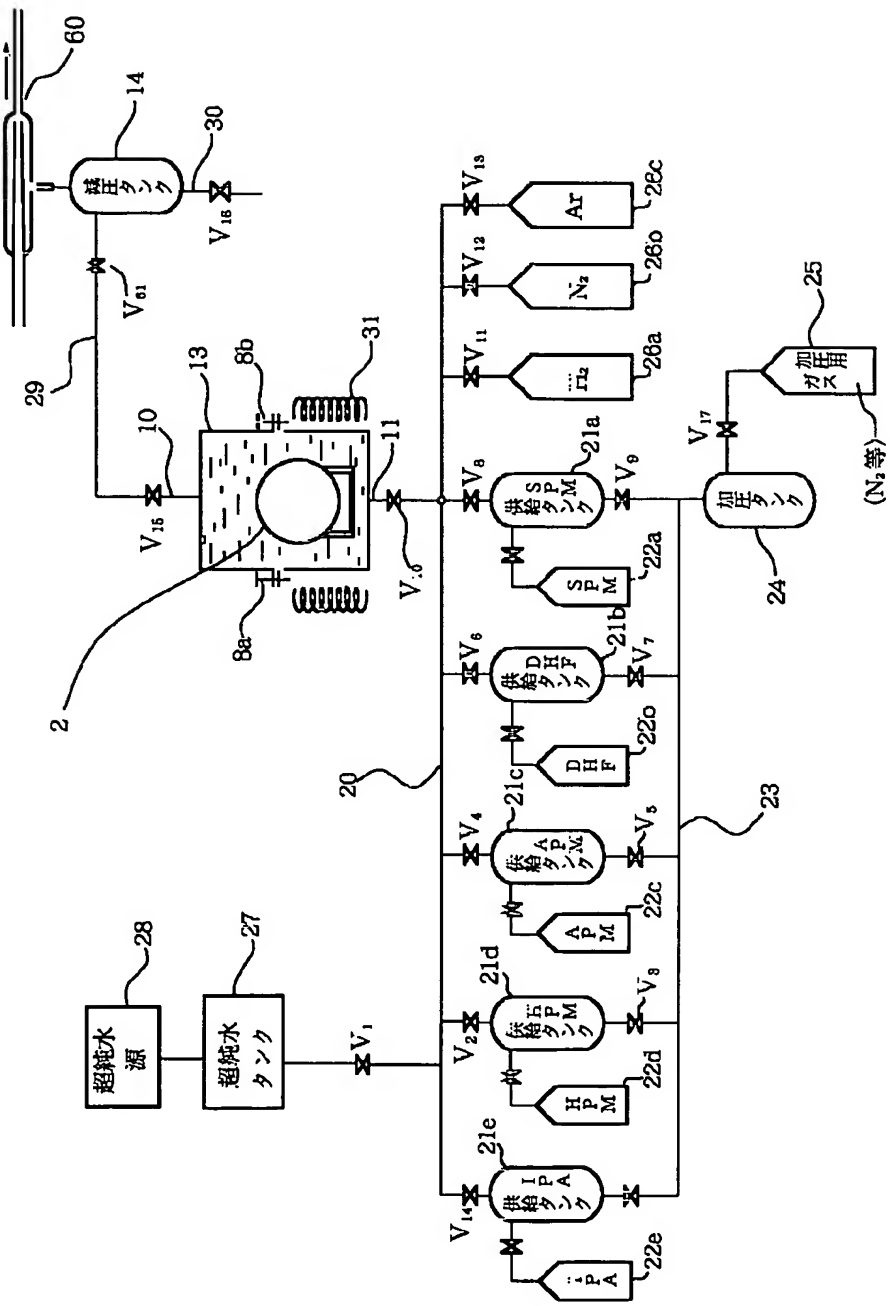
【図2】



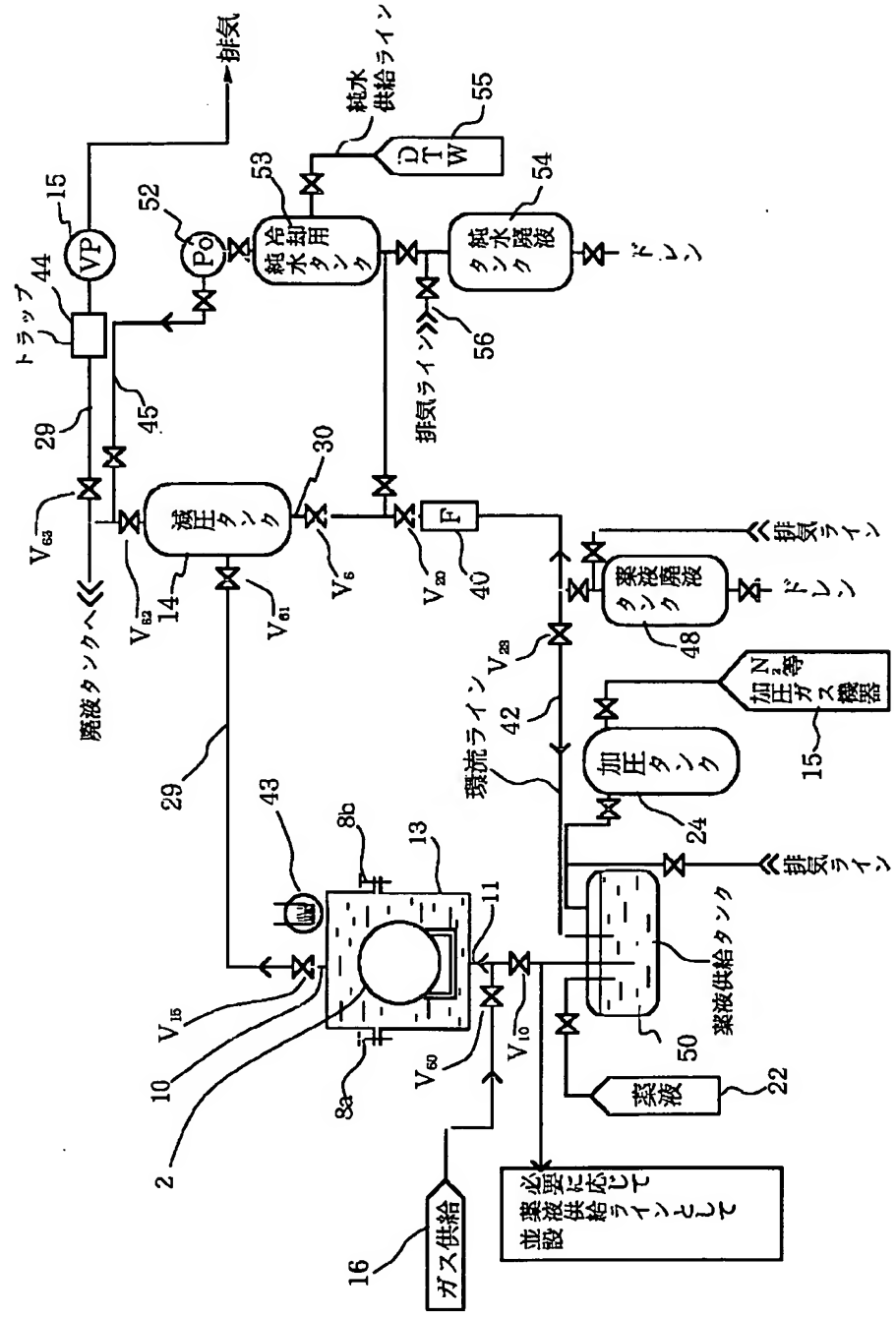
【図1】


VP
15
14
30
ドレン
V_{63}
V_{62}
V_{16}
V_{61}
36
V_{64}
29
13
8b
10
11
V_{15}
d
a
c
b
2
8a
V_{10}
35
V_{62}
20
V_{13}
Cl_2
26c
V_{12}
N_2
26b
V_{11}
H_2
26a
25
ガス用加圧
$(N_2$等)
V_{17}
V_8
供給SPMタンク
21a
V_9
加圧タンク
24
SPM
22a
V_6
供給DHFタンク
21b
V_7
DHF
22b
21c
V_4
供給APMタンク
V_5
23
APM
22c
28
27
超純水源
超純水タンク
V_1
V_2
21d
供給HPMタンク
V_3
HPM
22d
21e
V_{14}
供給IPAタンク
IPA
22e

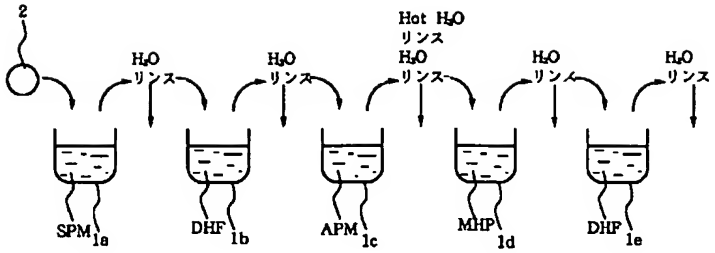
【図3】


60
14
30
減圧タンク
V_{18}
V_{61}
29
13
8b
31
10
11
V_{15}
V_{10}
2
8a
V_{13}
Ar
26c
V_{12}
N_2
26b
V_{11}
26a
25
加圧用ガス
V_{17}
(N₂等)
V_8
供給SPMタンク
21a
V_9
加圧タンク
24
SPM
22a
V_6
供給DHFタンク
21b
V_7
DHF
22b
20
21c
V_4
供給APMタンク
V_5
23
APM
22c
28
超純水源
27
超純水タンク
21d
V_2
供給HPMタンク
V_3
V_1
HPM
22d
21e
V_{14}
供給IPAタンク
IPA
22e

【図4】


排気
純水供給ライン
DTW
55
53
52
15
VP
PO
純冷却用タンク
54
純水廃液タンク
ドレン
トラップ
44
56
排気ライン
45
29
30
減圧タンク
F
40
排気ライン
廃液タンクへ
V63
V62
14
V61
V6
V20
廃液タンク
ドレン
48
V28
加圧N2等ガス機器
42
環流ライン
加圧タンク
15
24
29
43
8b
13
排気ライン
11
10
V15
V60
V10
8a
2
50
薬液供給タンク
薬液
22
必要に応じて薬液供給ラインとして設置
16
ガス供給

【図5】


2
H₂O
リンス
H₂O
リンス
Hot H₂O
リンス
H₂O
リンス
H₂O
リンス
H₂O
リンス
SPM
1a
DHF
1b
APM
1c
MHP
1d
DHF
1e

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